REPORT

OF THE

SECRETARY OF AGRICULTURE

1893.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.

[PUBLIC RESOLUTION—No. 18.]

JOINT RESOLUTION to print Agricultural Report for eighteen hundred and ninety-three.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed five hundred thousand copies of the Annual Report of the Secretary of Agriculture for the year eighteen hundred and ninety-three; one hundred and ten thousand copies for the use of the Senate, three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture.

SEC. 2. That the sum of three hundred thousand dollars, or so much thereof as may be necessary, is hereby appropriated, out of any money in the Treasury not otherwise appropriated, to defray the cost of printing said report.

Approved, April 10, 1894.

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REPORT

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SECRETARY OF AGRICULTURE.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., November 20, 1893.

To the PRESIDENT:

In the discharge of duty the Secretary of the U. S. Department of Agriculture has the honor to submit his report of the condition of that Department, as to efficiency and current expenses, on March 7, 1893, and from that date down to the present time.

ORGANIZATION OF THE DEPARTMENT.

This Department was instituted by act of Congress in February, 1889. It is, therefore, the youngest in the Executive branch of the Government of the United States, and not yet perfectly emerged from the period of formation. Even its objects, its duties, and its possibilities are only dimly defined or vaguely surmised. It is difficult to deduce clearly from the law which created it the functions that the lawmakers designed it to exercise. It is still more difficult to determine where duty in the management and direction of this Department begins and where it ends, under existing statutes. As organized, the Department of Agriculture offers opulent opportunities for the exercise of the most pronounced paternalism. But there are many proper ways in which the Federal Government may legitimately serve the cause of agriculture, though it is neither necessary nor desirable that this Department should attempt duties legitimately belonging to the States, and which only they can discharge as their respective statutes provide or direct.

RELATION OF THE DEPARTMENT TO THE STATE EXPERIMENT STATIONS.

The legal and proper relation between the duties in behalf of agriculture devolving upon this Department and those reserved to the several States of the Union has been rendered more complicated by the

act of March, 1887 (known as the Hatch act), creating experiment stations throughout the States and Territories, and also, under the color of law, establishing an anomalous partnership between the Government of the United States and the governments of the respective States for the conduct and encouragement of State agricultural experiment stations. An enormous annuity will accrue to the agricultural colleges with which the experiment stations are connected when the maximum figures are reached through the operation of the act of August, 1890 (known as the Morrill act), which will aggregate nearly two millions of dollars. But this is additional to the income from the almost limitless land legacy bestowed by the act of 1862, which has already realized to the agricultural colleges more than eight millions of dollars, and is not yet exhausted. But over that vast sum of money the Federal Government exercises no practical supervision nor the slightest control. The appropriation now made to experiment stations is $745,000, and, improperly, it appears in the appropriation bill charged to the U. S. Department of Agriculture.

As to that sum of money the Secretary of Agriculture has no direction whatever, except as to $25,000 thereof, which must be expended under his direction, in the interests of the experiment stations, through the Office of Experiment Stations, established in the Department of Agriculture, for the purpose of merely advisory functions. This appropriation by the General Government is unlike any other public moneys legislated out of the Treasury of the United States, because there is no officer of the United States authorized to direct, limit, control, or audit its itemized expenditure.

Section 3 of the act creating experiment stations ought to be so amended as to either give the United States Department of Agriculture a larger direction of the methods of expending the annual appropriations made for experiment stations, or so as to decisively determine that the Department has no control over it whatever, and is not required even to "give advice." In short, the annual appropriation of between $700,000 and $800,000 made for experiment stations ought to be charged to experiment stations directly, and they entirely divorced from departmental direction; or the law should provide that the Secretary of Agriculture shall have some power to direct and to restrain the disbursements of the Government moneys in each of the experiment stations of the United States, so as to insure only a legitimate expenditure of the same.

To-day each State draws from the Federal Treasury its pro rata share for its experiment station, and the only accounting required under the law for that money to the United States Treasury officials is the declaration and vouchers of the State authorities that the money has been expended under their direction. No detailed account as to how the money has been expended, to whom, or for what it has been paid out, is required. Current rumor in some of the States and Territories, so

universal, pronounced, accentuated, and vehement as to have secured great credence, indicates that some of the moneys appropriated for experiment stations have been diverted from legitimate public purposes and turned to those of a personal and not patriotic character. Thorough investigation, either by a committee of Congress or by some person authorized by law to make it, will demonstrate either the verity or the falsity of such evil reports. And it seems due to gentlemen who have the experiment stations in charge—some of whom are of the most exalted personal and scientific character—that such investigation be made at an early day. Properly pursued it can harm no one who ought not to be harmed. Investigation heightens and brightens the esteem of the public for those who, in official positions, have been proved faithful and efficient. It brings dishonor and disgrace to those only who have been unfaithful and inefficient. Complete investigation into the management of each experiment station in the United States and Territories will, therefore, certainly elevate in public esteem and render still more illustrious those distinguished scientists who have faithfully and efficiently discharged their duties as directors. And it will just as certainly uncover, demolish, and disgrace those, if any there be, who have frittered away the public funds, rendered inefficient service, and established as solid reputations which were only thinly plated with pretense. Investigation will build up the strong; it will destroy the charlatan and the pretender in science, as in all other human pursuits.

FUNCTIONS OF FOREIGN AGRICULTURAL DEPARTMENTS.

The Republic of the United States of North America is a government evolved from the experiences of all the governments which man has instituted since he began his civilized career. It was presumably made up of that which, to its founders, our ancestors, seemed the wisest and best that humanity had developed up to the time when they undertook to establish and protect liberty by organic law. Therefore, the Government of the United States, after an existence of more than a hundred years, is a result of the experiences of the Old World adapted to the environments of the New, and broadened by the further experience and wisdom of its own citizenship. And as the Department of Agriculture is still in an experimental stage, it is deemed only a prudent sagacity to ascertain what its parallels or synonyms in the older governments of the globe are accomplishing.

Therefore the proper authorities of Great Britain, of Prussia, of France, and of Italy were requested to furnish this Department terse statements of their functions and operations, and subjoined are the facts obtained from each of the prenamed governments, arranged in the order of their reception:

BRITISH BOARD OF AGRICULTURE.

To the ambassador of the British Government resident in Washington, Sir Julian Pauncefote, the Department is largely under obligations

for the following statement concerning the British Board of Agriculture, which was established in 1889:

The British Board of Agriculture consists of four departments: (1) Veterinary; (2) statistical, intelligence, and educational; (3) land; (4) ordnance survey.

The duties of the veterinary division are practically parallel to those of the Bureau of Animal Industry of the U. S. Department of Agriculture. There seems to be, however, no provision for the carrying on by the British Board of Agriculture of scientific investigations. The funds for such work are included in the general appropriations for the Board, except the sum appropriated by the parliamentary act of 1890, for the investigation and eradication of pleuro-pneumonia. For that purpose during the current fiscal year the English Government expends $75,000.

The department of the British Board of Agriculture known as the statistical, intelligence, and educational, embraces the collating and publishing of statistics in relation to agriculture. The intelligence branch is charged with collecting information respecting crop prospects at home and abroad. It likewise collects facts relating to agriculture in general; and it procures and publishes scientific information relating to insects and fungi injurious to plant life.

The educational branch inspects agricultural colleges and schools and the agricultural work of county councils and administers the parliamentary funds for agricultural education and experiments.

The land department differs from any bureau or division in the U. S. Department of Agriculture because of the difference between this and most foreign countries in the way of land tithes, land improvements, etc., as is sufficiently indicated by the mention of the five distinct branches into which the business of this department is divided. These are the inclosure and commons, copyholds, tithes, land improvements and survey, and land drainage.

The ordnance survey department, which was transferred from the army to civil administration in 1870, and in 1890 placed under the board of agriculture, is charged with the execution of the surveys of the United Kingdom. The board of agriculture has no jurisdiction in Ireland.

The staff of the board, exclusive of the ordnance survey, consists of a president, who is a privy councilor and member of Parliament, a permanent secretary, and assistant secretary, directors of the several departments, legal advisers, veterinary inspectors, etc.

The total annual expenditures of the British Board of Agriculture for the current fiscal year aggregate $1,420,345. Of that sum the ordnance survey department is charged with $1,093,550, and the board itself, including the other three departments, with $251,795. And, as before mentioned, for the suppression of pleuro-pneumonia is set apart the sum of $75,000.

The foregoing instructs us as to the governmental supervision of agriculture in Great Britain, and shows the annual cost thereof.

MINISTRY OF AGRICULTURE OF PRUSSIA.

Next in importance to our people, because of the vast number of American citizens who speak the language of Germany, is the Ministry of Agriculture of Prussia, which is divided into the three divisions of Agriculture, Domains, and Forests, the functions of which are summarized in the following paragraphs:

In the accompanying statement of the appropriations for the Ministry of Agriculture for the fiscal year 1889-'90 are given some notes, relating especially to the second and third items, explaining the scope and functions of the minister as to

agriculture. Of the second item for the high court of agriculture it is sufficient to say that it is a court of appeal from the decisions of the general committees. These committees, which, as the statement shows, absorb over 40 per cent of the appropriation for agriculture proper, are, as defined in a blue book published by the British Government, "to give effect to all legislation affecting land and agriculture." These committees are eight in number, so dispersed throughout the Kingdom that their several jurisdictions cover the entire Empire. Each committee is presided over by a president, who is assisted by numerous councilors, secretaries, and clerks, besides other employees, such as land surveyors, special assessors, mechanics, engineers, etc. Through these committees and their presiding officers the minister of agriculture readily keeps in touch with the agricultural interests of all Germany.

The principal educational and experimental establishments maintained under the head of "education and science" are the high school in Berlin and the agricultural academy at Poppelsdorf, the pomological institutes at Proskau and Geisenheim, and an establishment at Weisbaden for chemical experiments. Besides these educational institutions, however, there are a number of agricultural schools distributed through the different provinces which, though not governmental institutes, are aided by subsidies from the Empire to the extent of some $33,000. Subsidies are also granted to laboratories in which experiments and investigations are carried on in the interest of agriculture to the extent of some $25,000 or $26,000 more, the sum varying according to the earnings of the laboratory, but showing a steady decrease during the past six or seven years because of increased earnings.

Of the item for "veterinary affairs" some $30,000 are given in subsidies to the veterinary schools in Berlin and Hanover. The department, moreover, employs eleven chief veterinarians, with a sufficient staff of assistants, to superintend veterinary affairs on the frontiers. The amount devoted in the appropriations to cattle and horse breeding consists principally of subsidies to the three principal establishments for horse-breeding, while encouragements in the way of prizes, etc., are awards to individual breeders.

The land improvements supervised include bridge-building and the building and repairing of dikes, embankments, etc., and the maintenance of civil engineers to construct and inspectors to superintend such works.

The item of "extraordinary expenses" was to cover similar work, presumably of a more exceptional character. The other sections of the work of the minister of agriculture, forestry, and domains presents features entirely differing from any which prevail with us, inasmuch as the vast area, which is the property of the State, yields by careful management a gross revenue of $14,000,000, which, after paying all expenditures (amounting to $8,637,500), leaves to the German Government a net revenue of nearly $6,000.000. So with domains controlling an area of only 1,313 square miles, a revenue of over $7,000,000 is raised.

Appropriations, 1889–'90—Ministry of Agriculture of Prussia.

Staff of ministry	$109, 465
High court of agriculture	34, 376
General committees	1, 284, 721
Educational—scientific	259, 571
Veterinary department	222, 003
Cattle and horse breeding	175, 855
Land improvements	353, 654
Subsidies, pensions, etc	142, 675
Extraordinary expenses	226, 000
Fisheries	67, 965
	2, 876, 285

Forestry:		
Expenditures		$8, 637, 500
Forest area ... square miles	10, 425	
Revenue	$14, 495, 000	
Net revenue	$5, 857, 500	
Domains:		
Expenditures		1, 776, 505
Area ... square miles	1, 313	
Revenue	$7, 286, 685	
Net revenue	$5, 510, 180	
Total		13, 290, 290

The foregoing from the highest German authority presents briefly the operations of the Ministry of Agriculture of Prussia and its appropriations for a single fiscal year. It is obvious that the governmental forests of 10,425 square miles are so managed as to be not only of great sanitary advantage, but also a source of net revenue, amounting to $5,857,500 in a single year. The forestry of Germany, and the important position it holds in the estimation of those who administer the Government, is scientifically suggestive to all the nations of the earth, and especially to the Government of the United States, wherein so little attention has been paid to a question of such vital necessity as the conservation and renewals of the woodlands of this continent.

FRENCH MINISTRY OF AGRICULTURE.

The Ministry of Agriculture in France is, in a large degree, similar to our own Department. But it supervises many things with which this Department has no connection and over which it can have no control, because of the different conditions and requirements of government which prevail in the several States of the United States. For instance, one of the principal French bureaus is devoted to agricultural education and to the encouragement of agriculture, and embraces a general inspection by the Ministry of Agriculture of education and educational matters throughout France. That includes the practical schools of agriculture, dairying, and also the National Agronomic Institute. The further duties of the Ministry of Agriculture are set forth in the following résumé:

The Ministry of Agriculture also disposes of subsidies given to agricultural undertakings, premiums, awards, and bounties awarded to agriculture, including those conferred at cattle shows and exhibitions of agricultural machinery.

A second bureau has charge of veterinary schools and services, including the inspection of all imported cattle, the supervision of sanitary police, and the indemnity for cattle slaughtered for sanitary preventive reasons.

A third bureau has charge of legislation and food products, and also has charge of parliamentary bills on agriculture and of the adjustment of the rural code, and discharges all the functions of a statistical bureau. These three bureaus constitute the Direction of Agriculture.

In addition to the Direction of Agriculture, which is one of the main divisions of the ministry, there is another main division, known as the Central Service. It is

divided into two bureaus. The first has charge of all the administrative details, appointments, promotions, transfers, and organization of the staff of the forestry division. Furthermore, it controls the receipt and dispatch of correspondence, the transfer of decrees and papers to Parliament, the estimates and all communications to the Superior Council of Agriculture, to the members of Parliament, and to other directors of the Government.

The second bureau of this service is charged with the control of accounts, all bookkeeping, the care of the archives, of the library, and the custody of documents. The most interesting feature of the French Ministry of Agriculture is that which places the Central Service under the control of a board of advisers, consisting of the minister himself, the director-general of agriculture, the Director of Forestry, the director of agricultural hydraulics, the director of the "haras" (horse-breeding establishments), the minister's private secretary, the senior officer of the Central Service, and the chief clerk of the same; all these—with the exception of the minister himself—are permanent officers. This board of advisers controls absolutely the conduct of the department, besides determining any question especially referred to it by the minister himself. All appropriations are submitted to it, and all promotions or penalties require its approval.

Subjoined is a statement showing the appropriations for the use of the French Ministry of Agriculture for the fiscal year of 1894. It gives a general idea of its wide scope and varied functions, for which next year's appropriations aggregate (exclusive of forestry, which is more than self-supporting) over five and a half millions of dollars. The vast sum provided as subsidies, bounties, and premiums in certain lines of culture to certain agricultural institutions and to undertakings in the line of rural engineering is worthy of notice, as is also the item of interest guaranteed to companies undertaking useful work in agriculture and for aid to sufferers from sundry casualties. But in no way can they be commended for emulation by the Government of the United States, except as to forestry.

Appropriations for French Ministry of Agriculture for 1894.

Salaries of the minister, staff of central administration, sundry expenses, publications, subscriptions to publications, inspection service, etc		$221,830
Agricultural education and breeding establishments, including salaries of teachers and employees, material, and plant	$319,000	
Veterinary schools	209,390	
		528,390
Subsidies to sundry agricultural institutions	400,000	
Subsidies to useful works in agricultural hydraulics	274,000	
Premiums or bounties in silk culture	800,000	
Premiums or bounties in flax and hemp culture	500,000	
Subsidies and expenses for the restoration of vineyards	200,000	
		2,174,000
Interest guarantied to companies undertaking useful public works		209,550
Encouragements to the horse industry		316,400
Maintenance of the "haras," or horse-breeding establishments		1,065,516
Epizootic diseases, including indemnity for animals slaughtered		115,560
Encouragements to agriculture, including delegates to foreign countries, traveling burses		380,000
Decennial statistics		12,000
Destruction of wolves		8,000

Analyses of butters and fats	$4,000
Agricultural hydraulics, policing and supervision of water, special investigations, and state works	279,700
Aid to sufferers from sundry casualties	474,000
Aggregating, with sundry other minor items, a total, exclusive of forestry and agriculture in Algeria, of	5,792,628

Forestry is provided for by a special appropriation of $2,644,000. The total appropriation for the Ministry of Agriculture, including forestry, is $8,436,628. Forestry is, however, given separately, because it returns an income much in excess of its expenditures. The receipts of the Government from its forests and the amounts received from town governments and public establishments for the supervision and management of their forests aggregate $5,600,000. The appropriations for forestry include the cost of technical instruction in that subject to the amount of $35,000. The actual products of the forests bring $5,400,000 into the treasury of France.

It is well for Americans to observe that forestry in the foregoing résumé of the French Ministry of Agriculture is treated with that consideration which its importance to all other vegetable life, and also to the continued existence of humanity itself upon this earth, merits and demands.

ITALIAN GENERAL DIRECTION OF AGRICULTURE.

Besides the relations existing between agriculture and the Governments of Great Britain, Germany, and France, it may be well to briefly set forth those established between the Government and the agricultural interests of Italy.

The department which in this country has special charge of the agricultural interests is known as the General Direction of Agriculture, and forms a branch of the Ministry of Agriculture, Industry, and Commerce. The duties of this department are distributed among four divisions:

The first deals with agriculture proper; the second, known as the division of zootechnie, deals with all that relates to cattle, insects, game, and fisheries; the third has charge of the woods and forests; the fourth of agricultural hydraulics (which include irrigation, drainage, and land improvements) and mines.

There is also, in addition to the General Direction of Agriculture, a Bureau of Agricultural Legislation.

The first division above mentioned, dealing with agriculture proper, is subdivided into three sections:

Section 1 relates principally to agricultural instruction, having supervision of experiment stations, laboratories, collections, schools of agriculture, and of the diffusion of agricultural instruction in training schools for teachers, as well as in elementary schools.

Section 2 has charge of measures for the improvement of vine culture and horticulture, the investigations relating to the diseases of plants, supervision of agricultural shows and exhibitions, fertilizers, and agricultural machinery, and is especially charged with the establishing of chambers of agriculture. Section 2 is in immediate communication with the council of agriculture, to be described hereafter.

Section 3 has charge of all matters pertaining to agricultural industries and economic questions.

Connected with the first division of the General Direction of Agriculture are certain consulting bodies. The first of these is the council for agricultural instruction, of which the minister is chairman, and which includes besides 14 members, 9 being appointed for three years by the King, 4 being elected, 1 each year, by the council

of agriculture, while the fourteenth is the director-general of agriculture *ex officio*. The council meets in regular session twice yearly, but a committee of the council, consisting of the deputy chairman, 3 members selected by the minister, and the director-general, meets monthly.

The council of agriculture consists of (1) 24 presidents of chambers of agriculture, 6 presidents of agricultural associations, including economic societies, veterinary societies, or other bodies established in the interest of forestry, agriculture, or stock-raising, who are selected yearly by the minister from a list of agricultural bodies entitled to representation; and (2) 15 councilors, holding appointment by royal decree and selected for their knowledge of economic and other branches of learning connected with agriculture.

The following officers are members *ex officio:*

(1) The Secretary-general of the Ministry.
(2) Director-general of agriculture.
(3) The chairman of the zootechnic commission.
(4) The chairman of the horse-breeding commission.
(5) The chairman of the council of woods and forests.
(6) The chairman of the commission on viticulture.

Two members are appointed by royal decree president and vice-president, but whenever the minister is present he occupies the chair. The secretary of the council is a clerk in the department of agriculture, nominated by the minister.

The regular annual sessions of the council take place in April, but the minister may summon extraordinary meetings. Members of the council who do not reside in the capital are allowed traveling expenses and a subsistence of $3 per diem while attending the sessions. The proceedings of the council are published at the Government's expense. The council is represented by delegates on various other boards, such as the commission of customs valuation, the council for the assessment of railway rates, the council for agricultural instruction, the council for salt and tobacco monopolies, and on the college of customs experts.

The commission on viticulture consists of 12 members appointed by royal decree, 4 of whom are appointed each year and serve for three years. The chairman is the director-general of agriculture, while the chief of the first division and three inspectors of agriculture are *ex officio* members.

The system of advisory councils prevails also in regard to the second division, particularly with reference to the horse-breeding service, in which the director-general is assisted by a council consisting of the director-general of cavalry, the director of the second division in the agricultural department, the chief officer of the breeding establishments, 2 delegates elected by the veterinary schools, 2 delegates from the horse-breeding societies, 1 officer of cavalry nominated by the minister of war, and 1 other member appointed for three years by the minister of agriculture. This council meets twice a year.

The third division, relating to "woods and forests," and the fourth, relating to "agricultural hydraulics," or what may be called rural engineering, are practically organized on very much the same line as the divisions already described, including the invariable advisory council, consisting of several officials serving *ex officio* and other persons, appointed either by the minister or by royal decree.

The estimates for maintenance of services under the general direction of agriculture aggregated, for the fiscal year ending in 1890, $1,424,613, of which nearly $1,200,000 was for ordinary expenditures, the others being classed as extraordinary. It must, however, be borne in mind that, exclusive of some $23,000 expended in supplying private landowners with young trees, the administration of the forestry department shows a balance or surplus over expenditures aggregating, for a period of five years, over $100,000.

From the foregoing synopses, which show what four of the oldest nations of the earth are doing to conserve and encourage successful

agriculture within their respective domains, it is possible for Americans to draw many useful lessons. Therefore they have been prepared and submitted as didactic data to which agricultural colleges, experiment stations, and practical farmers of the United States may turn for useful suggestions. In a government like this, while it is not desirable to copy all the forms of administration which prevail in the Old World, the substance may, in most cases, be taken and assimilated to our use, so as to be of universal beneficence to our citizens. It is our duty and destiny to seize the good and reject the bad, as it may be discovered, in all the departments of all forms of human government.

EXPENDITURES.

When the present Secretary of Agriculture took charge of the Department there were upon its pay rolls 2,497 employees. To-day, however, there are on the pay rolls of the Department of Agriculture only 1,994, a reduction of 503 employees. In justice, however, there should be deducted from the present current expenses of the Department the salaries of 11 clerks who have been, at its request, detailed to the U. S. Civil Service Commission, and are still paid their salaries, amounting to the sum of $16,200 per annum, out of the appropriation for the Department of Agriculture.

The strenuous endeavor has been, in view of a depleted public treasury and because of the imperative demands of the taxpayers of the United States for economy in the administration of their Government, to rationally reduce expenditures by the elimination from the pay rolls of all persons not needed for an efficient conduct of the affairs of the Department. At the outset conditions of an unsatisfactory character, due largely to a system which permitted the grossest inequality in compensation to the employees of the Department, were confronted. Cautiously and conscientiously the erasure from the pay rolls of the Department of the names of all unnecessary employees and the increase of its usefulness have been undertaken with persistent purpose and not a passive vigor of will. There has also been an attempt, not by any means yet completed nor satisfactorily successful, to equalize compensation.

The expenses of the Department of Agriculture during the first quarter of the present year aggregate but $345,876.76, as against $402,012.42 for the parallel period of the fiscal year 1893. And it is gratifying to observe that the saving up to this time is not less than 12 per cent per annum on current expenses. In verification of the intention to make at least this reduction permanent, the estimates for the next fiscal year, which have been submitted to Congress, are less by $369,656.94 than those for the current fiscal year, which will end June 30, 1894.

Comparative statement showing amount of appropriations for the Department of Agriculture for the fiscal year ending June 30, 1894, and amount of estimates submitted by the Secretary of Agriculture for the fiscal year ending June 30, 1895.

	Appropriation, 1894.	Estimate for 1895.	Increase.	Decrease.
Office of the Secretary	$81,900.00	$77,500.00	$1,200.00	$5,600.00
Division of Accounts and Disbursements	17,700.00	17,700.00		
Division of Statistics	146,100.00	146,100.00		
Division of Botany	38,600.00	33,600.00		5,000.00
Division of Entomology	29,800.00	29,800.00		
Division of Ornithology and Mammalogy	27,360.00	27,360.00		
Division of Pomology	11,300.00	11,300.00		
Division of Microscopy	6,700.00	7,300.00	600.00	
Division of Vegetable Pathology	25,600.00	25,600.00		
Division of Chemistry	39,000.00	32,000.00		7,000.00
Division of Forestry	27,820.00	29,820.00	2,000.00	
Division of Records and Editing	6,300.00	8,500.00	2,200.00	
Division of Illustrations	19,000.00	18,200.00		800.00
Division of Seeds	148,920.00	44,000.00		104,920.00
Document and Folding Room	10,460.00	11,000.00	540.00	
Museum	7,840.00	6,840.00		1,000.00
Library	3,000.00	6,000.00	3,000.00	
Agricultural experiment stations	745,000.00			745,000.00
Office of Experiment Stations		25,000.00	25,000.00	
Experimental garden and grounds	34,000.00	32,000.00		2,000.00
Furniture, cases, and repairs	10,000.00	10,000.00		
Postage	5,000.00	5,000.00		
Contingent expenses	25,000.00	25,000.00		
Road making and management	10,000.00	10,000.00		
Experiments in the manufacture of sugar	20,000.00	10,000.00		10,000.00
Irrigation investigations	6,000.00	8,000.00	2,000.00	
Nutrition		10,000.00	10,000.00	
Fiber investigations	5,000.00			5,000.00
Bureau of Animal Industry	850,000.00	700,000.00		150,000.00
Quarantine stations for neat cattle	15,000.00	12,000.00		3,000.00
Weather Bureau	951,100.00	854,223.06		96,876.94
Total	3,323,500.00	2,233,843.06	46,540.00	1,136,196.94

Amount of items representing decrease of appropriations	$1,136,196.94
Amount of items representing increase of appropriations	46,540.00
Total decrease	1,089,656.94
Deducting amount appropriated by Congress for State experiment stations, and improperly included in the appropriation for the Department of Agriculture	720,000.00
Net decrease	369,656.94

CHANGE—PERMANENCY.

Among the heads of divisions in the Department of Agriculture changes under the present administration have been exceedingly few, because the gentlemen in charge of the several divisions are generally skilled scientists. They are experts in their respective professions. Many of them are known throughout the scientific world, in which they have worked all their lives, and their investigations are common to the English, German, French, and Italian languages.

Dr. George Vasey, the Chief of the Division of Botany, died early in March, 1893. He was known as a great botanist and a high authority in his specialty throughout the world. His loss is profoundly mourned by his countrymen who were laboring in the same delightful field with himself, and by botanists over the sea, throughout Great Britain, and the Continent. His position was immediately tendered to, and accepted by, Mr. F. V. Coville, his most capable assistant in that division. The other changes occurred because of resignations. Mr. A. W. Harris, Director of the Office of Experiment Stations, resigned

to accept the presidency of the Maine State College of Agriculture and the Mechanic Arts, and his place was filled by the promotion of Mr. A. C. True, who was his assistant. Maj. B. F. Fuller resigned his position as Chief of the Division of Accounts and Disbursing Officer, and was succeeded by Mr. F. L. Evans, who had been his faithful first aid for several years.

With the exception of one division—that of Statistics—these are the only changes made in the chiefs of divisions where technical knowledge and skill are required, and in each instance the vacancy was filled with certain advantage and good results to the service by the promotion of experienced assistants. These promotions are a recognition of long, faithful, competent, and useful labors in behalf of the Government. They are intended to stimulate ambition, fidelity, and industry among all well-disposed employees of this Department.

Each promotion in the Department ought to be hereafter in itself a declaration that the person advanced in rank and salary has a superior record for merit and efficiency, and is capable of a higher grade of service, and therefore entitled to an increase of compensation.

THE CLASSIFIED SERVICE.

The classified service is defective, owing to the arbitrary advance in the rank and pay of clerks, without requiring a higher grade of service or any increase of skill or intelligence. Thus we find inequities in compensation. One clerk may be drawing $1,800 per annum because he is in the $1,800 class, and yet doing only the work adapted to a person in the $840 class. These inequalities of compensation are, perhaps, due more to the appropriation acts creating statutory positions than they are to the law creating the U. S. Civil Service Commission, or to the rules and regulations which that Commission has adopted.

An obvious method of rectifying this injustice is to be found in making the appropriations *in gross* for the pay of the clerical force of each Department, and leaving the head thereof to determine, from the character and quality of the service required, how much each clerk shall be paid. In all great business concerns—mercantile, financial, and manufacturing—compensation depends upon the quality and character of the service, and the promptness and fidelity with which it is rendered. There can be no good reason urged against the Government of the United States securing efficient services in the same manner that they are secured by the successful business interests of the country. No one can take charge of a Department of the Government, and of his own volition employ servants of mediocre ability or inefficient, except at the cost of his own reputation and much loss to the public service and public purse.

In the Department of Agriculture there are 87 employees who came in after examination and certification from the eligible lists by the U. S. Civil Service Commission. But there have been 638 persons

placed in the classified service of the Department of Agriculture, by Presidential orders. Of that number, 118 were ordered in by President Arthur; by President Cleveland during his former administration, 90 at one time and 116 at another; while President Harrison, by his order of January 5, 1893, placed 314 persons in the classified service of the Department of Agriculture. So that there have been placed upon its pay rolls 725 persons in the classified service.

The erroneous impression that a clerk in the classified service is protected, or that he has any vested right in an office, so as not to be amenable to higher authority because of delinquencies or malperformance of duty, seems to be quite generally entertained, and especially by those who have come into the service through "an order" rather than by a rigid examination. That this is not true, and that tenure of office in any Department depends upon industry, fidelity, and promptness, ought to be italicized in the daily routine of duties by all those having authority; and it should be understood that personal merit and efficiency alone, rather than any extraneous influence, can secure and hold promotions in the public service.

It is further suggested that, in the interest of an efficient service, the Civil Service Commission should provide a noncompetitive examination for any employees of a Department whom the head thereof shall select from those placed in the classified service by a Presidential order, and that in the case of noncertification by the Civil Service Commission after being thus examined such employees should be dropped from the rolls.

DISTRIBUTION OF SEED AT THE PUBLIC EXPENSE.

The first United States Commissioner of Patents, Henry L. Ellsworth, in the year 1836 conceived the idea of distributing new and improved varieties of seed among the farmers of the United States, and from that time he patriotically procured the seed and distributed it at his own expense until the year 1839, when, upon his recommendation, Congress appropriated $1,000, to be taken from the Patent Office funds, for the purpose of collecting and distributing rare and improved varieties of seeds, and prosecuting agricultural investigations and procuring agricultural statistics. And from this small beginning, fifty-four years ago, the Seed Division of the Department of Agriculture has grown to its present unwieldy, unnecessary, and extravagant proportions; so that in the year 1892 there was appropriated the sum of $135,400 for the purpose of purchasing seeds, bulbs, and cuttings for gratuitous distribution.

In 1891 the seeds purchased cost, in round numbers, $40,000, while the labor and expenses of putting them up and distributing them alone cost the Department $50,675.75. If there ever was a good reason for the original purchase of new and improved varieties of seeds for gratuitous distribution there is certainly now no valid reason for the purchase and distribution of ordinary seeds, bulbs, and cuttings which

are common in all the States and Territories, and easily obtainable at low prices by the people generally. This is particularly true since the establishment of an experiment station in each State and Territory. These stations, by their very character and name, are the proper agencies to experiment with and test new varieties. Each station is presumed to be in charge of a director, of such scientific agricultural training and so well informed as to the requirements of soil, climate, and other environments, that he is especially qualified to make the tests to determine the value of each kind. From the first appropriation down to the last, the Government of the United States has expended in seed distribution the sum of $3,101,600, an average during fifty-three years of $58,520.75 each year.

The dimensions of this distribution of seeds by legislation and legislators are made visible in the light of the fact that for this calendar year enough cabbage seed has thus been sent out to plant 19,200 acres, a sufficient quantity of beans to plant 4,000 acres, of beets enough to plant 2,500 acres, of sweet-corn to plant 7,800 acres, together with enough cucumber seed for 2,025 acres, enough musk and watermelon seed to plant 2,675 acres; and that, altogether, this Department has sent out, in more than nine millions of packages, a sufficient amount of flower and vegetable seeds to plant 89,596 acres of land.

That this popular dissemination is regarded altogether as a gratuity, and not of any appreciable advantage, is proved by the failure of any general recognition of benefits by those who have received the packages, notwithstanding the fact that the instructions of the Department require them to report results.

In view of the above facts, this enormous expenditure, without compensatory benefits, ought to be abolished. Therefore, looking to its final abolition, more than $100,000 for the fiscal year ending June 30, 1895, has been stricken from the estimate for this purpose, and the $35,000 estimated ought to be confined strictly to the purchase of new and improved varieties, and even these ought to be distributed only through experiment stations. Thus seed will be tested and found valuable or otherwise. After the test has been completed by the experiment station the propagation of the useful varieties and the rejection of the valueless should be left to the common sense of the people, who will have been informed as to local value and adaptability by the experiment station bulletins. An experiment is simply a test. It determines that a thing is of value or that it is worthless. There can be no experiment in perpetuity, and this illustrates the fallacy of purchasing and distributing, year after year, the ordinary varieties of turnip, cabbage, celery, and other seeds.

For the fiscal year ending June 30, 1893, there were paid out by the Department of Agriculture, directly for seeds, $66,548.61; and the remainder of the appropriation of $130,000 was absorbed in the cost of putting them into packages and delivering them for distribution. And

to the above operating expenses of the Seed Division there must be added its fixed charges in the form of statutory salaries, amounting to $13,520, and this swells the annual expenditure to $143,520. The number of packages of seed distributed by the Department for the year 1892 was 7,700,000, and they cost 2 cents apiece, while the average cost of the 9,000,000 packages of seed distributed during the present fiscal year is 1 cent and 4 mills per package.

Out of the appropriation made for seed distribution for the year ending June 30, 1894, after all the above detailed work of purchasing and distributing, there will be more than $20,000 covered back into the Treasury of the United States.

The following is a comparative statement of seeds purchased in 1892-'93 and 1893-'94, showing an increase in the quantity of seed obtained for each dollar expended during this year, a saving having been effected and an increase in quantity secured in each variety purchased:

Seeds purchased in fiscal years 1893 and 1894.

	Corn.	Cotton.	Beans.	Peas.	Vegetable seed.	Flower seed.	Miscellaneous.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Pounds.*	*Pounds.*	*Bushels.*
1893-'94	2,400	600	2,000	3,030	135,635	1,905	165
1892-'93	2,175	551	1,940	2,800	98,366	1,582	....
Increase	225	49	60	230	37,269	323	165

Percentage of increase in quantities purchased in 1893-'94 over 1892-'93.

Corn	.09⅝
Cotton	.08⅙
Beans	.03
Peas	.07½
Vegetable seeds	.27
Flower seeds	.17

Cost of seed.

Total cost of seeds for 1892-'93	$66,022.59
Total cost of seeds for 1893-'94	54,617.10
Saving to the Government	11,405.49

BUREAU OF ANIMAL INDUSTRY.

The amount appropriated for this Bureau for the current fiscal year is $850,000; the estimate for the ensuing year is $700,000.

TEXAS FEVER REGULATIONS.

The regulations of 1892 have been enforced during 1893, with slight modifications exempting certain counties in North Carolina, Virginia, and Arkansas from quarantine regulations. The results have been very satisfactory. The large stock yards of the country have kept

free from infection. Occasional local outbreaks have been largely such as could have been effectually guarded against by the owners of the affected cattle. The efficiency of control would be greatly increased by an amendment to the law imposing a penalty for violation of the regulations promulgated by the Department, by railroad companies transporting infected cattle.

EXPORT CATTLE INSPECTED.

The total number of inspections made during the past fiscal year was 611,542. Only one-tenth of the cattle tagged were rejected as not in proper condition for export. The exports of live cattle show a falling off of about 25 per cent from the preceding year—a falling off which occurred entirely in the last half of the year, and which seems to have been due to an increase in the price of American export cattle.

VESSEL INSPECTION.

Bureau inspection of cattle-carrying vessels has resulted in a continual reduction in the percentage of losses of animals at sea. The percentage of loss in 1891 was $1\frac{3}{5}$ per cent; in 1892, seven-eighths of 1 per cent, and for 1893, forty-seven hundredths, or less than one-half of 1 per cent.

INSPECTION OF IMPORT ANIMALS.

The total number of animals arriving from Canada during the year and inspected by Bureau officers was 462,092. The total number of animals imported from transatlantic countries was 1,297. No contagious diseases were found among the imported animals. But it is essential that a law should be enacted providing for the inspection of horses imported into this country, because they are subject to several contagious diseases, one of which (not indigenous to this country) has already been introduced by importation which will involve for its eradication a considerable outlay of money.

INSPECTION OF AMERICAN CATTLE IN GREAT BRITAIN.

It is deemed wise to continue this inspection, to learn the condition in which American cattle arrive, the extent of losses at sea, and to investigate the alleged cases of pleuro-pneumonia reported by British inspectors. Such allegations have been made in the cases of 54 animals during the year. The diagnosis has in each case been pronounced incorrect by the inspectors of the Bureau of Animal Industry, and the history of these animals, traced through the record, has clearly shown that no contagious disease existed where the animals had been raised and fed, or where they could have been exposed in transit.

CONTAGIOUS PLEURO-PNEUMONIA.

No case of this disease having been discovered in this country since March 25, 1892, and a careful inspection having been maintained for

twelve months thereafter, sufficient to furnish evidence which would remove all apprehension on the part of our own people, and be accepted as perfectly conclusive by foreign governments, it was deemed safe and judicious, on April 1 of this year, to dismiss the force engaged in this inspection.

MEAT INSPECTION.

The meat inspection has continued as prescribed in the regulations of March 25, 1891. The extent of the microscopical inspection has, however, been greatly reduced, the intention being to confine it rigidly to products intended for direct export to countries exacting the same. On the other hand, the inspection of all animals, both before and after slaughter, intended for export and for interstate trade, has been insisted upon and regulations regarding this inspection were issued September 13, 1893. So far as the microscopic inspection extends it has been made more thorough by insisting upon a double inspection in order to secure perfectly reliable results.

EXPORTS OF INSPECTED PORK.

During the year ending June 30, 1892, exports of inspected pork aggregated 38,152,874 pounds. For the year ending June 30, 1893, they aggregated but 20,677,410 pounds. Exports to countries directly requiring inspection were for 1892, 22,025,698 pounds, and for 1893, 8,059,758 pounds. The falling off in this export trade was not confined, however, to inspected pork, the total quantity exported for 1892 being 665,490,616 pounds, while in 1893 it was only 527,308,695 pounds. The decrease is partially accounted for by the high prices of pork in this country throughout 1893. The microscopic inspection cost the Government 6½ per cent on the value of meat sold to the countries which demanded that inspection; and a comparison between the amount of meat so inspected and sold in 1892 to those countries and the amount sold to them in 1893 shows that microscopic inspection has not increased our foreign sales and that it does not pay.

ADDITIONAL LEGISLATION.

Existing law does not adequately provide for the authoritative and effectual destruction of condemned carcasses. Better provision for this purpose is rendered all the more necessary by the extension of the inspection already referred to. In the present law there is nothing which prevents the marketing of the carcasses of animals condemned by the Department, in the State where the animal is killed, nor can the Department follow such diseased carcasses, in the local market, to prevent their being shipped and sold outside of the State. The public can be properly protected against the use of such meat only through some legislation compelling the immediate destruction of any animal or carcass condemned by United States inspectors.

TUBERCULOSIS.

While contagious pleuro-pneumonia of cattle has been successfully eradicated, the cattle of the country are still afflicted with tuberculosis, a disease widespread and more dangerous to human life than pleuro-pneumonia. It is essential that the Bureau of Animal Industry should undertake without delay measures looking to its control. Investigations have been made during the past year as to the means of its communication and the method of its correct diagnosis. Much progress has been made in this direction by the studies of the Division of Animal Pathology. The work must now be extended, in coöperation with local authorities, until the danger to human life has been reduced to a minimum.

MALADIE DU COÏT.

The inspectors of the Bureau have been remarkably successful in combating a disease of the horse known as dourine or maladie du coït, of which an extensive outbreak occurred during the last year in Nebraska and South Dakota.

CIVIL SERVICE EXAMINATION OF INSPECTORS.

In this connection it is recommended that hereafter each applicant for the position of inspector or assistant inspector in the Bureau of Animal Industry be required, as a condition precedent to his appointment, to exhibit to the U. S. Civil Service Commission his diploma from an established, regular, and reputable veterinary college, and then submit to such an examination in veterinary science as that Commission may prescribe; and no one failing to pass that examination shall be eligible to either of the aforenamed positions. And, furthermore, it is advised that all the inspectors now in the service be required to pass through the same ordeal, namely, to show their diplomas and submit to a civil service examination.

DIVISION OF ENTOMOLOGY.

The amount appropriated for this division for the current fiscal year is $29,800, which amount remains unchanged in the estimates for the ensuing year.

Satisfactory experiments with remedies against the spread of the hop plant-louse have been made in Oregon and Washington. Considerable damage has been reported in several sections by a destructive grasshopper of nonmigratory form. A bulletin was widely circulated containing remedial suggestions, which resulted in prompt measures being taken and much damage averted. Arrangements have been made for an investigation, by a resident of Japan, of insects injurious to agriculture in that country, particularly of those which would be likely to be introduced into this country. A request was made recently, by the State board of Massachusetts, that the Secretary of Agricul-

ture should further the efforts of the board in getting Congressional appropriations to aid them in fighting the gypsy moth. There did not, however, seem to be sufficient justification for such assistance, and it was accordingly refused. At the same time the Department cheerfully tenders all legitimate coöperation in the work, and is ready, as in the past, to give the board the benefit of its best efforts and experience.

Reports of occurrences of the pernicious scale at Charlottesville, Va., have reached the Department. This is the first appearance of this insect on the Atlantic coast of the United States, and calls for prompt educational coöperation on the part of this Department, and this has accordingly been freely tendered. The Entomologist, Prof. Riley, strongly recommends, as part of the work for this fiscal year, an attempt to introduce the Caprifig insect from Smyrna into California, and to introduce from Ceylon the giant bee of India; therefore, the interested attention of fruit-growers in southern California, and of bee-keepers in the several States is directed in a special manner to these suggestions.

DIVISION OF ORNITHOLOGY AND MAMMALOGY.

The amount appropriated for this division for the current fiscal year is $27,360, which amount remains unchanged in the estimates for the ensuing year.

The efforts of this division have been directed toward completing investigations begun several years ago, and the preparations of results for publication. Two economic bulletins have been published—Hawks and Owls of the United States, and Prairie Ground Squirrels of the Mississippi Valley. These last probably cause more injury to crops in the United States than any other mammals except the pocket gophers. Many maps were prepared showing a detailed geographical distribution of mammals and birds. The United States is practically divided into a definite number of belts or zones, each one characterized by the presence of certain animals and plants, thus intimating what normal agricultural products each zone is best fitted to produce. The division is engaged in tracing these various zones across the continent, and in the preparation of large scale maps showing boundaries in different colors. These maps will illustrate to the farmer the location of his farm with reference to the life zone in which it lies, thus giving him a key to the crops most likely to succeed. Biological surveys begun in 1889 have been continued the present season and carried across the State of Wyoming. Other field work has been instituted in California, Oregon, Utah, Nevada, the Dakotas, Nebraska, Kansas, and Colorado, with special reference to the determination of the northern boundary of the zone known as the Upper Sonoran. The report of the Death Valley Expedition has been published, and the bulletin on the Common Crow is now ready for the printer.

DIVISION OF BOTANY.

The sum appropriated for this division for the current fiscal year is $38,600; the estimated expenditures for the next year are $33,600.

During the present year the series of forage experiments, both in the subarid lands of the West and in the humid region of the Gulf States, have been concluded and final reports on them are now in preparation. The importance of the results attained in the experimental cultivation of crops without irrigation, at Garden City, Kans., has been more accentuated during the present season than ever before. The wheat and Indian corn crop of western Kansas and adjacent regions for the present season has been, as is well known, almost a total failure, so much so indeed that in many quarters not enough grain has been produced to suffice for next year's sowing. In the midst of these conditions the Jerusalem corn on the experiment farm has now a good stand and a luxuriant growth, promising a yield of 20 to 40 bushels per acre. This product is an admirable substitute for Indian corn, and from present experience in feeding it promises to be quite as palatable to stock. In the forage experiments Hungarian brome has been demonstrated to be clearly superior to all other forage plants thus far tried in the subarid regions. With a rainfall from January 1 to September 1 of 8 inches (more than half of which fell during the month of July) this grass produced a crop of hay, estimated at 1 ton per acre, greedily eaten by stock and of high nutritive value.

For the future work of the Division of Botany there are contemplated, in addition to a continuation of the present work of the division, certain lines of investigation in connection with the herbarium for which there is urgent demand. One such line of work is the maintenance of a seed collection, to contain seeds of all weeds and cultivated plants, as well as those of our wild species which are eaten by birds and animals. Such a collection in the hands of an expert is required to enable the Department to answer inquiries regarding the purity of seeds put on the market by dealers, the detection of weed seeds in grain samples, the identification of the vegetable contents of bird-stomachs, the detection of adulterations in many commercial products, and other questions of a similar nature. In other lines also it is proposed to develop and make use of the economic side of the herbarium, taking up botanical work, with which State experiment stations are not in a position to deal.

A card catalogue of the botanical library of the Department of Agriculture has been completed, to which are now being added titles of all botanical works accessible in the other libraries of Washington. Several collectors have been employed during the season, confining their work principally to the arid and subarid portions of the West.

DIVISION OF VEGETABLE PATHOLOGY.

The sum appropriated for this division for the current fiscal year is $25,600; this sum remains unchanged in the estimates for next year.

The work of this division has been divided about equally between the laboratory and the field. In the laboratory a number of diseases affecting fruits, grains, and other useful plants have been studied. The field work has covered improvement of machinery used in spraying, the determination of the proper time or times for applying fungicides, and the trial of substances known or supposed to have fungicidal value. Another important branch of this work is the improvement of cultural methods with a view of preventing diseases, thereby enabling plants to be grown to the highest state of perfection.

The scattered nature of the literature on fungicides has made it desirable to bring together in convenient shape all possible information on the subject. With this object in view more than 1,500 foreign and domestic references were secured during the year, 700 of which have been consulted in the original, and critically reviewed. This matter, together with the published and unpublished data of the division, will form the basis of a bulletin that will include a discussion of the chemistry and toxicology of the more important fungicides, together with a critical résumé of the facts bearing on the fungicidal value of the various substances now employed as remedies for plant diseases.

The diseases of citrous fruits and other subtropical plants have been studied during the year by two assistants stationed in Florida. The horticulturists of that State have greatly aided the investigations by their hearty support. Several orange-growers have given parts of their groves for experiments, and the citizens of Eustis have erected a six-room one-story laboratory, and given it to the division for its exclusive use. This has very materially aided in enabling the appropriation available to be applied wholly to the purchase of the actual means of study, and to meeting the expenses of field experiments. A plat of 2 acres lying near the laboratory has been established as an experimental garden. The laboratory was furnished early last spring, and since then the studies of the various diseases of citrous fruits have been pushed as rapidly as possible.

There are four principal diseases of the orange and lemon now being investigated. They cause an aggregate annual loss of fully $250,000. All of these maladies are of an obscure nature, but it is claimed that the investigations already made have thrown very considerable light on three of them and render an intelligent trial of remedies possible. The fourth disease, the orange blight, although one of the most destructive, is still very imperfectly understood, but it is hoped that the greatly increased facilities afforded by the laboratory will render it possible to discover the cause and the remedy for the disease.

The causes affecting the fruitfulness of pears and apples have been made the subject of further study. The important discovery, made incidentally while investigating the effects of the transmission of disease germs through the flowers by bees and other insects, that many of our common varieties of pears are incapable of self-fertilization, was

pointed out last year. At the same time attention was also called to the fact that this discovery explained why large blocks of single varieties of pears often failed to bear satisfactory crops, even though the flowers were abundant and all other conditions excepting those insuring cross-fertilization were present. In order to obtain additional evidence on this point, the experiments made in 1892 were repeated the past season, the work being carried on at Rochester, N. Y., and Parry, N. J. The results of this work verify the conclusions obtained in previous years, showing that to insure the highest fruitfulness pear and apple orchards should consist of mixed varieties. Where large blocks of pears have failed to fruit through lack of cross-fertilization the trouble may be remedied by top-grafting with a different variety to supply the necessary pollen. A bulletin containing a full account of the work, together with the results obtained, is now ready for the printer.

The work in California has been continued along practically the same lines as in previous years. The vine disease has been made the subject of special study, and, in addition, several maladies of other fruits have been under investigation. The rust of prune leaves, a very troublesome disease in some sections, has been successfully combated by spraying. The blighting or blasting of grape flowers, commonly known as coulure, has been studied in the northern part of the State. This trouble, which is often due to constitutional defects in the vine, frequently causes the loss of the entire crop. During the year a series of experiments in crossing and hybridizing the vine was carried on in the hope that by this means varieties free from coulure might be obtained.

The year has brought to a close the experiments with fertilizers for the prevention and cure of peach yellows. This work, covering a period of four years, was carried on in the heart of the great peach region of the Maryland and Delaware peninsula. The results, which have been published in full in Bulletin No. 4 of this division, show, it is claimed, conclusively, that the disease can not be prevented or cured by applying to the soil any of the well-known plant foods. Thousands of dollars have been spent by growers every year upon fertilizers and other so-called remedies of a similar nature, and it is believed the results of the investigations made by the division will result beneficially in checking useless expenditure. Since the completion of the fertilizer work the special agent in charge of the investigations has been able to devote more time to laboratory researches into the causes of the disease. Laboratory investigations and field experiments, having in view the discovery of a natural means of infection, have also been under way. So far yellows is only known to be communicated by budding, but all the facts at hand indicate that the disease may have the power of spreading in other ways.

The experiments in the treatment of wheat rust, begun in 1891, have

been continued; the results of the first season's work, covering the treatment of seed and soil separately and combined, spraying the plants at various intervals, etc., were published in the early part of the year. During the past season the work was wholly confined to spraying the plants, it having been shown by the previous year's labors that the seed and soil treatments were worthless, so far as the prevention of rust was concerned.

DIVISION OF POMOLOGY.

The sum appropriated for this division for the current fiscal year is $11,300; this sum remains unchanged in the estimates for next year.

The work of this division has included and concluded the collection of fruit models and edible nuts, which has been on exhibition at the World's Fair during the summer. The importance of the subjects illustrated and the measure of success attained have justified the labor applied. Nearly 1,000 models of fruits, comprising 625 varieties, and more than 300 packages of wild and cultivated nuts, compose the collection. If provision is made for the gradual and judicious enlargement of this collection it may afford a means of determining the range of climatic variation in our cultivated fruits.

The economic work has included the identification of specimens sent by growers for that purpose. The collection of models, in addition to its scientific value, has been found an effective help in the work, and it is believed that the accuracy and reliability of this branch of the work of the division is increasing. An examination of the office records shows that about three-fourths of the specimens sent for this purpose have been scientifically identified. During the year more than 100 new varieties not previously described have been received for examination, and have been reported on as to their value for propagation and introduction.

The preparation of reports for publication on the culture of different fruits has been intermittently continued. Current work is urgent and imperative, owing to the perishable nature of the specimens received and the importance of immediate and full replies to inquiries. The bulletin on nut culture is ready for publication; that on small fruits is well under way, and the tabulation of replies to the circulars on apple culture, of which several thousand were sent to apple-growers during two previous years, has commenced.

The preparation of the revised catalogue of American fruits has been continued, this duty having been intrusted to a properly qualified special agent. It is believed that the work can be completed during the coming year. The monograph on the grape yet remains unpublished.

DIVISION OF GARDENS AND GROUNDS.

The sum appropriated for this division for the current fiscal year is $34,000; the estimated expenditures for next year are $32,000.

This division is charged with the care of the 35 acres of grounds of the Department. It has supervision also of the glass structures, which cover a space of about three fourths of an acre and are well filled with plants. A considerable area under glass is devoted to the propagation and growth of plants for distribution throughout the United States and for exchange with foreign countries. The superintendent determines any questions relative to practical horticulture, floriculture, fruit-growing interests, and economic gardening and garden architecture that may be submitted to the Department.

The following plants were distributed during the past year: Strawberries, 30,400; grapes, native and foreign, 15,000; olives, 2,734; camphor, 2,696; figs, 3,000; miscellaneous, consisting in part of oranges, currants, loquats, vanilla, black pepper, and various semitropical plants, 2,875; tea, 2,690; coffee, 710; raspberries, 422; and pineapples, 576. In all, upwards of 60,000 plants.

Applications for plants are often bewildering, enumerating plants indigenous in all the zones of the globe, embracing the most northern and the most tropical of species, to be tested perhaps in localities where but few of them could live, and of such extensive variety that no single plant establishment in the world could furnish them. Requests of this kind involve considerable explanatory correspondence which can not be avoided. And while an effort is made to meet all reasonable demands in this direction, the Department exercises discrimination as to the kinds of plants sent out, availing itself of the experience gained by testing the hardiness and other qualities of plants previous to their distribution.

In the Southern States, where many species of semitropical plants may be successfully cultivated, a great desire is manifested to experiment with crops the culture of which has not hitherto become general. This desire increases proportionately as a knowledge of the benefits to be derived from diversified culture grows. There is much inquiry as to the olive and the fig; and of these good collections are maintained, and many thousands are annually propagated and sent to regions best fitted for their growth.

DIVISION OF FORESTRY.

The amount appropriated for this division for the current fiscal year is $27,820; the estimate for the ensuing year is $29,820.

The condition of the forestry industry in this country still remains markedly unsatisfactory. Under our present system the efforts of the Division of Forestry of this Department are restricted to purely educational work, and this has been carried on for over fifteen years without perceptibly abating wasteful lumbering and destructive fires, which are destroying our primitive forest supplies and inflicting permanent injury upon the lumber interests and seriously menacing agriculture. With all due allowance for the absence of verifiable statistics, it may be

safely asserted that the yearly wood consumption in the United States is twice as great as our estimated forest area is capable of producing annually. In this connection it must be noted that the Division of Forestry has not been sufficiently endowed to undertake the task of collecting reliable statistics as to the consumption and growth of wood material and the prospects of supply and demand, which should form the basis of a wise government policy. Meantime supplies are waning and proofs are accumulating of the malign influence of deforestation.

The policy of setting aside forest reservations from the public domain —a policy far too long delayed but now happily inaugurated and applying to a total area of 17,000,000 acres—should be followed by a well-considered supervision of the same, and the remaining timber lands on the public domain should be withdrawn from disposal. Without forests to take care of or power to shape the forest policy of the country, this Department can only suggest plans for a more rational treatment of our forest resources.

In the absence of appropriations justifying statistical inquiry, attention was turned to the scientific side of the forestry problem by this division. The main expenditure of funds has been in the investigation of the timbers of the United States, as to their strength and mechanical properties when grown under varying climate and in different soils. This work has been carried out, so far, in a way which has elicited favorable comment from competent critics at home and abroad. The investigation of the longleaf pine demonstrates that the bleeding of this tree for turpentine is not injurious to the quality of its timber. This discovery has enhanced the value of the forests so treated in the Southern States by several million dollars. Legislation is furthermore earnestly recommended which shall preserve forest reservations and provide for a rational disposal of ripe timber on Government lands, similar to that contemplated by House bill No. 119, Fifty-third Congress, amendment of section 24.

While recognizing the differences between our system and those of European countries which are successfully applying methods of forest administration inapplicable to the United States, we must, nevertheless, turn to those that have made forest administration a success for suggestions, and the Republic of Switzerland is commended as furnishing the most practical economic data in this particular.

It is not inappropriate to call attention to an act to repeal timber-culture laws, and for other purposes, approved March 3, 1891, and to suggest further legislation, if it be deemed necessary, to properly construe section 24 of that act, which authorizes the President of the United States to "set apart and reserve, in any State or Territory having public land bearing forests, *in* any part of the public lands wholly or in part covered with timber or undergrowth, whether of commercial value or not, as public reservations, and the President shall, by public proclamation, declare the establishment of such reservations and the limits thereof."

Members of the American Forestry Association, and all other citizens interested in the conservation of woodlands and the reafforestation of denuded areas of lands not suitable to tillage, will be pleased to read in "Dankleman's Zeitschrift, September, 1893," the deserved compliment which the reviewer of the United States timber examination work (instituted by B. E. Fernow, in charge of forestry interests) has unreservedly awarded this Department. The judgment of Mr. Fernow's work in this division, in his scientific investigation of the several varieties of timber, as to strength, durability, and general utility, in relation to the conditions of growth, is all the more valuable because the gentleman who gives it is himself in charge of forestry work of a similar character for the Prussian Government. And it is, therefore, a matter of congratulation, among all those who realize the importance of forestry work in the United States, to read the following unequivocal and merited commendation of the work of this division in the Department of Agriculture:

> This plan of work is as remarkable for its scope as for consistent pursuit of an eminently practical result. Although Germany has accomplished a great deal in some directions of this field, especially in investigating the laws of growth and wood structure, we are yet far from having such a comprehensive and indispensable knowledge even of our most important timbers. We must admit, with a certain sense of humiliation, that the Americans show us what it is we really ought to know, and that they have already by far surpassed us in the elaborate organization for these investigations.

If, in less than a decade, Americans have in a forestry specialty surpassed Germany, why can not we a generation hence rejoice in the most efficient forestry system of the world? And can the result be reached in a popular government through other than educational institutions, beginning with the common schools? And to initiate a tree-conserving and tree-planting crusade that shall be efficient and benignant will be the constant aim of this Department.

OFFICE OF FIBER INVESTIGATIONS.

The appropriation for this division for the current fiscal year is $5,000.

Interesting experiments in the culture of flax have been made the present season under direction of the Department in the State of Washington. Results have been equally as satisfactory as in the case of flax experiments in Oregon in 1891. The excellence of the straw, as shown in the samples received, promises well for the future of the flax industry. The importance of its development in our own country is indicated in the steady decline in flax production abroad, which in time must lead to a large increase in the price of flax and linen products imported. Flax grown in Minnesota in the past year and manufactured for this Department in one of the largest mills in the East was declared by experts preferable to the same grade of imported flax. Inventions in the line of labor-saving machinery in flax culture have been stimulated by the prominence given to flax-growing in the

past few years by this Department. No opportunity has as yet been afforded to test these machines practically and pronounce upon their economic merits.

In connection with our flax industry, the United States consul-general at Frankfort, Germany, recently presented a report containing facts full of interest to our flax-producers. He states that during the year 1892 Germany imported over 60,000 tons of raw flax fiber, which was utilized by 13 large spinneries. Over 55,000 tons came from Russia, which country, it seems, also exports largely to England and Belgium, indicating a demand for the raw fiber in these countries. Germany admits this product free of duty; and owing to the differences on the question of the tariff existing between Germany and Russia, the consul pertinently suggests the possibility of the flaxseed-growers of the United States, who now throw away immense quantities of the straw, utilizing it by taking the trouble necessary to save and prepare it for export. It is more than probable that in certain sections of this country, and at the expense of a little time and trouble, the flax straw now wasted may be so saved as to compete with the Russian flax straw in the markets of Germany, England, and Belgium.

The interest in ramie continues and the cultivation of jute is attracting a great deal of attention. The possibility of the production of these fibers in certain sections has been demonstrated, but further experiment is needed to settle the question of cost of production and machinery for cleaning. As an evidence of the value of the bulletins issued from this office upon the fiber question, it may be stated that some of them have been published privately, others by State legislation, while one has been translated into Spanish and republished in South America.

DIVISION OF CHEMISTRY.

The amount appropriated for this division for the current fiscal year is $59,000; the amount estimated as required for the ensuing year is $42,000.

DOMESTIC SUGAR PRODUCTION.

The work in connection with sugar-beet production during the past year almost proves the adaptability of vast sections of this country for this branch of modern agriculture. For the first time in this country a crop of sugar beets has been grown from domestic seed produced under the most rigid scientific culture. That crop has been highly satisfactory. The continuance of experiments with sugar beets is recommended by the chief of this division in order to verify the opinions, which, in his judgment, are already justifiably formed. The experiments in sorghum sugar may, it is believed, be discontinued, the results of experiments already made leaving apparently nothing more for the Federal Government to undertake. A stage is now reached

when individual enterprise can and should take advantage of what the Department has accomplished.

Experiments with the sugar cane in Florida seem to justify the expectation that the latitude and climate of the lower portion of that peninsula are adapted to the production of a cane that will compete successfully with the Cuban variety. Further experiments seem to be necessary to determine whether any deficiency in the soil may be economically supplied, and for this reason their continuance for another year is recommended on the advice of Prof. Wiley, chief of the division.

INVESTIGATION OF FOOD ADULTERATIONS.

Results of investigations directly invite the recommendation that whenever food preservatives are used in the preparation of canned goods the fact should be stated on the can, leaving the responsibility of consumption to rest upon the purchaser. In the absence of a law controlling the manufacture of adulterated commodities and leaving the investigation of samples to the discretion of the Secretary of Agriculture, it has been concluded to limit the investigation to samples offered by purchasers or consumers, thus avoiding any unjust discrimination between the manufacturers of edible commodities.

SOIL INVESTIGATIONS.

An investigation into the chemical character of different typical soils of the United States is desirable. It will determine the best manner of analyses and teach their practical utility. The sum of $3,000 has, therefore, been estimated for the ensuing fiscal year "to enable the Secretary of Agriculture to undertake a special investigation of the different typical soils of the United States to determine their chemical character, their physical properties, and especially the nature of the nitrifying organisms which they contain."

DIVISION OF MICROSCOPY.

The appropriation for this division for the current fiscal year is $6,700; the estimate for the ensuing year is $7,300.

Supplying information to farmers and others in relation to the culture of mushrooms has occupied the attention of the division the past year. The principal work of the division for the coming year will be the investigation of the cotton of various countries, ascertaining the relative length, elasticity, tensile strength, and diameter of fiber. It is claimed that a discovery has recently been made in this division regarding the crystallization of the glycerides of fatty acids, particularly of the medical and edible seed oils, by which it is believed that adulterations of seed oils will hereafter be more easily detected.

It is probable that in the near future the work now assigned to this division can be divided between the Divisions of Botany and Vegetable

Pathology, and its accomplishment provided for by only slightly increasing the appropriations of these divisions.

OFFICE OF EXPERIMENT STATIONS.

The appropriation for this office for the current fiscal year is $25,000; and the same sum is estimated for next year.

The principal work of the Director of the Office of Experiment Stations and his assistants is the examination of the work of agricultural experiment stations in the United States and other countries, and the collection and publication of data regarding investigations for the information of station workers and those interested in the colleges of agriculture. The wide extent of agricultural research is shown by the fact that there are now 320 experiment stations in operation in the different countries of the world, and the number and importance of the publications issued by them are increasing. The task of keeping thoroughly informed of their work and of supplying information regarding them is a formidable one.

Twenty-three documents, aggregating nearly 2,000 pages, have been issued from the office during the past year, including the fourth volume of the Experiment Station Record, which contains abstracts from 321 reports of American stations, 71 publications of this Department, and 190 abstracts from foreign works. Leading foreign specialists have contributed résumés to this volume. Its index is practical, and extends to the work of agricultural experiments throughout the world for the current year.

NUTRITIVE VALUE OF FOODS FOR MAN.

Investigations as to food values in this country have thus far related almost exclusively to improvements in the kinds and culture of crops and to their use as food for domestic animals. It is both desirable and practical that questions relating to the use of our agricultural products as food for man should also be considered. A suggestive article submitted by Mr. Edward Atkinson, regarding the establishment of food laboratories in connection with the experiment stations for this purpose, was recently published by this Department.

The work of collating information regarding the methods and results of such food investigations at home and abroad has already been undertaken by this Department. This information will serve as a basis for further studies by such stations as have the proper equipment of men and resources for this work. None others should attempt it. In furtherance of this line of inquiry an appropriation of $10,000 has been recommended "to enable the Secretary of Agriculture to investigate and report upon the nutritive value of the various articles and commodities used for human food, with special suggestions of full, wholesome, and edible rations, less wasteful and more economical than those in common use, $10,000; and he is hereby authorized to require,

free of charge to him from such agricultural experiment stations as he may select, services in the chemical analysis of such food material to an amount in cost from any one station [of] not exceeding $500."

OFFICE OF IRRIGATION INQUIRY.

The appropriation for this division for the current fiscal year is $6,000; the estimate for the ensuing year is $8,000.

The final report, in four parts, of the work of this office upon artesian and underflow investigation was brought to a conclusion and printed last year. Since then the division has collected and published an abstract of all the important laws of the several States and Territories on irrigation and water rights. This publication has been issued as Bulletin No. 1 of this division.

The division has continued the collection of methods and results of irrigation, as practiced successfully in the States and Territories of the arid regions. This work will be continued and extended to cover the simplest method of accurate water measurement, the proper quantity of water needed for each kind of crop raised, and an investigation into the adaptability of the best mechanical appliances for the purposes of the irrigation farmer.

OFFICE OF ROAD INQUIRY.

The Fifty-second Congress made an appropriation for the purpose of investigating practical methods for the improvement of the public roads of the United States, and in accordance with that enactment, Gen. Roy Stone, of New York, recognized as a superior civil engineer, and thoroughly identified with the popular movement toward the improvement of the highways in the several States, has been placed in charge of the inquiry. It will be thoroughly pursued in the direction indicated by Congress, but it is too early to deduce any conclusions as to possible results. Necessarily some months must elapse before a sufficient volume of evidence from each of the several States can be obtained upon which to base any intelligent report as to possibilities or probabilities in road improvements. In any event, it seems now that the only efficient service which the Department can render to the people in this regard will be in the collection and distribution of practical knowledge and suggestions. Therefore, for the ensuing year the same sum ($10,000) is estimated as needed to continue the investigation, if Congress deems it expedient or desirable.

DIVISION OF ILLUSTRATIONS.

This division prepared for the World's Fair an extensive exhibit of original drawings and paintings of illustrations which have appeared in the publications of this Department during the past fifteen years; it also exhibited the different methods employed in reproducing our illustrations—wood-engraving, photo process, and chromo-lithography.

During the year the division completed 503 plates of illustrations, containing upward of 900 figures; 107 of these plates were water-color paintings, 30 of which were of large size. These illustrations represent work for twelve divisions of the Department, and include also the special work for the exhibit at the Fair. The work has been satisfactory, and covers every line of illustrative art. In the interest of efficiency and economy a reorganization in the working force of the division has been recommended, looking to increased efficiency at a reduced cost.

DIVISION OF RECORDS AND EDITING.

The appropriation for this division for the current fiscal year is $6,300; the estimate for the ensuing year is $8,500.

During the first nine months of the current year the Division of Records and Editing handled 66 publications, representing nearly 5,000 printed pages, exclusive of maps, charts, circulars, reprints, and publications issued by the Weather Bureau from its own printing office. Reprints have been ordered during this period of 26 publications, and the cost of the printing as charged or estimated for by the Public Printer has been for the nine months $43,229.14. Of publications printed by order of Congress, prepared in the Department and handled in this division, there have been, in addition to the above, 4 publications aggregating 1,223 pages, and the whole number of copies of these several publications aggregate over 2,627,000. Estimates of cost of publications now in the hands of the Public Printer, but incomplete, aggregate over $6,000.

The enormous amount of printing devolving upon the Department, and the great increase thereof during the past four or five years, shows conclusively that the vicious principle of promiscuous free distribution of publications must be abandoned, and only a certain limited number thereof furnished free to libraries and educational institutions and the remainder sold at a moderate price. The Secretary of Agriculture should be authorized to dispose of the plates to publishers, under suitable restrictions as to prices to be charged, such sale to confer copyright privileges upon the purchaser.

It should be stated that the yearly average cost of the printing and binding for this Department, exclusive of the Annual Report of the Secretary, the Annual Report of the Weather Bureau, and the Annual Report of the Bureau of Animal Industry, and of such other bulletins or reports as may be ordered by special resolutions of Congress, is about $80,000.

DOCUMENT AND FOLDING ROOM.

The appropriation for this division for the current fiscal year is $10,460; the estimate for the ensuing year is $11,000.

Just as the farmer may properly plow, carefully cultivate, and successfully mature a bountiful harvest, and then lose the results of all his

labor by having no proper places in which to garner them, so the Department of Agriculture, no matter how efficiently its various divisions may have made their investigations, nor how promptly they may have been published, may become absolutely useless if its educational and didactic documents are not skillfully folded and with celerity sent out to the general public. As an almanac ten years old is valueless for the practical purposes of to-day, so many of the bulletins upon specialties connected with agriculture, pomology, and the Bureau of Animal Industry are comparatively useless to the people unless placed in their hands with the utmost dispatch.

In view of these facts, the force in the Document and Folding Room has been thoroughly reorganized, and it is now so systematized that a citizen calling there and inquiring for any publication ever issued by the Department of Agriculture, can secure the same (if any copies are remaining) without delay. Hereafter each publication will be circulated as soon as it is issued, and no delay will be tolerated and no distribution deferred. The gentleman in charge of the Document and Folding Room was selected exclusively because he had been foreman in a trade-circular addressing company for many years, and under his immediate supervision a large force had been employed, which each month mailed millions of documents to the public.

THE AGRICULTURAL LIBRARY.

The appropriation for the library for the current fiscal year is $3,000; the estimate for the ensuing year is $6,000.

Even those who are the most sensitive as to the invasion of the economic domain by statutes admit that in the proper protection of property, liberty, and life, a government should in every practicable manner facilitate the education of its citizens. Therefore the estimates for the purchase of useful books for the library of the Department of Agriculture have been increased for this year $3,000.

Two copies of every volume copyrighted in the United States are, under existing law, placed with the Librarian of Congress. Therefore he has duplicates of each work upon agriculture thus far copyrighted in the United States. It is suggested that Congress enact that its librarian transfer to the library of this Department one copy of each of the works bearing upon agriculture, horticulture, forestry, pomology, botany, and kindred topics now in his possession or that may come into his hands hereafter under copyright law. This would, without additional cost to the Government, and much to the depletion of the present inutility of duplicate books in the Congressional Library, add a great many valuable volumes to the agricultural literature of this Department.

THE WORLD'S FAIR.

The World's Fair at Chicago was an exhibit of the civilization of all the centuries condensed. In a single illuminated volume it presented

the fancies, the facts, the aspirations, and the achievements of humanity since it began a civilized career.

Under the direction of the Hon. Edwin Willits, who will in the near future, as Assistant Secretary of the Department of Agriculture, report thereon, this Department made a most complete and useful exhibit in each of the specialties represented by its several divisions. It is expected that the property belonging to this Department, which has been on exhibition at Chicago during the past summer, will be restored to its proper place before the 1st day of January, 1894. The $148,000 allotted to this Department for the purpose of making its exhibit at the World's Fair will have been nearly exhausted when the expense of repacking and returning shall have been liquidated, though it is possible that there may remain a few thousand dollars to be covered back into the Treasury of the United States.

MORE ROOM.

The Department of Agriculture has with surprising speed outgrown the domicile allotted to it at birth. More room in better buildings, with fireproof apartments, is sorely needed. The Division of Botany has collections of plants and herbariums of a value of $150,000, and in case of their destruction they could not be replaced even at that cost.

The Division of Forestry has likewise a valuable assortment of tested woods for which there is no parallel in the world. This also, in case of conflagration, would be quickly and totally lost.

The Bureau of Animal Industry, in its laboratory and elsewhere, has a vast volume of valuable veterinary material which is in practical use for the illustrations and verifications in animal pathology from day to day. It has cost, besides large pecuniary outlay, years of patient research by the best trained veterinarians and investigators of bacteriology. Its loss to the animal industry of the country could not be repaired in a decade, not even with a government treasury to stimulate speed in the work of restitution.

But it is needless to enumerate the values intrusted to each division which—from Entomology to that of Disbursements and Accounts—are the result of diligent study and years of practical labor and trained experience. The Department is, from its museum to its garret, crowded with useful, beautiful, rare, and valuable results of the scientific labors which have been persistently pursued during the last twenty-five years by learned chiefs in its several divisions.

In view of the foregoing facts stands the demand for new buildings ample to accommodate safely the Department of this time and the developed Department of a century not yet born. And yet no appropriation for a commodious and permanent home in which to locate this Department can be reasonably asked in a period of depressed business and diminished revenue. But plans and specifications for a properly

devised and durably constructed building or buildings might possibly be provided—in the interest of economy—at no distant day.

WEATHER BUREAU.

The appropriations for this Bureau for the current fiscal year aggregate $951,100; the estimated expenditures for the ensuing year amount to $854,223.06.

During the past year the work of the Weather Bureau has been carried on with improved efficiency and economy. The reduction in cost of maintenance is nearly 10 per cent. The estimates for the fiscal year have been correspondingly reduced, with the confident expectation that, while more economically administered, the service will continue to improve in usefulness. A general reorganization of the Bureau has been partially effected. It is intended to modify expenses and magnify the value of the service to agriculture, commerce, and the people at large.

FORECASTS.

The attention of the employees of the Weather Bureau has been fixed more strongly than ever before upon the work of forecasting as the primary duty of the Bureau to the public. The former forecast room, Telegraph Division, and river and flood room have been consolidated in the Forecast Division and placed in charge of the assistant chief of the Bureau, Maj. H. H. C. Dunwoody, of the U. S. Army. The superintendence of the wind signal display stations and of the lake marine section has also been intrusted to this division. The staff of forecast officials has been assigned to this division, and during the months in which they are not on official forecast duty they are required to make daily, for practice, complete forecasts from the a. m. map, employing the remainder of their time in the investigation and preparation of reports upon practical meteorological problems. It is expected that these reports, several of which have been completed, will be of great value as practical aids to forecasting.

The system of giving each of the local forecast officials in the service a two months' course of instruction at this office in the preparation of the charts in use here and in making forecasts for the whole country, for practice, has been continued.

Arrangements have been made with the Light-House Board and the Superintendent of the Life-Saving Service whereby the keepers of light-houses and life-saving stations on the Atlantic coast will telegraph this Bureau during the hurricane season the occurrence of heavy ocean swells or other signs of the approach of hurricanes to our coast, these officials being exceptionally well located for this purpose. During the hurricane that struck our southern coast in the latter part of August, 1893, a report of a heavy ocean swell off Tybee Island, forwarded by telegraph by the observer at Savannah, was the earliest intimation of its approach.

The river and flood service has been reorganized by putting the making of the forecasts of river stages and changes in the hands of experienced observers at the principal river stations, assigning to each one to forecast a section of the river or rivers in his vicinity. These observers are furnished with all the available data of the rivers during previous floods, and directed to carefully study the same. They receive daily telegraphic reports of the stages of the rivers and amount of rainfall throughout their sections. These reports with their own experience and rules of practical value in river forecasting will, it is thought, enable them to make more precise predictions than were made under the old system.

The efficiency of the storm-warning system on the Great Lakes has been increased by the establishment of 6 display stations, and decided progress has been made in the work of ascertaining and charting the set of the lake currents. A very large number of bottles have been floated during this season for this purpose, and a preliminary current chart has been prepared and is in process of publication.

The investigation of the meteorological conditions that prevail over the Great Lakes has also been greatly extended. Over 100 new voluntary observers have been secured from among the masters of lake vessels. The collection of the data in relation to the currents and meteorology of the Great Lakes has entailed very little expense upon the Government. It will prove of great value to the lake marine.

In making telegraph contracts for the fiscal year a reduction of about 15 per cent was obtained on rates for the Weather Bureau. The construction of lines of telegraph and submarine cables from Alpena, Mich., to Thunder Bay and Middle Island, in Lake Huron, as authorized by act of Congress, was completed July 13, 1893, and both lines were put into operation on the day following. These lines aggregate about 25 miles of land lines and 5½ miles of cable.

Authority has been given for extensive general repairs to the line from Port Angeles to Tatoosh Island, Wash., and the line from Astoria, Oregon, to Fort Canby, Wash., and to that from Norfolk, Va., to Hatteras, N. C. This work, now well under way, will enhance the efficiency of these important lines.

The submarine-telegraph cable between Cape Charles and Cape Henry, Virginia, was broken and otherwise injured during the month of January, 1893. Efforts to recover the broken ends proved fruitless, and the cable itself was of little or no value to this service, and it was therefore legally disposed of last July. The construction of a railroad and telegraph line from Titusville, Fla., to Jupiter, Fla., renders the maintenance of the Weather Bureau telegraph line between those points needless. It will, consequently, be disposed of according to law.

THE DAILY WEATHER MAP.

The daily weather map is now issued at 72 stations of the Weather Bureau outside of Washington, D. C. The average issue is about

8,000 copies, or about 2,500,000 copies annually—a slight increase over last year. These figures by no means express the demand, which has grown to such proportions that it has sorely taxed the capabilities of the station force and the store of supplies. As a means of distributing forecasts and weather conditions the map is superior to any before devised. In its present form, however, it does not reach the multitude. An ideal system of distributing information collected by the Bureau would place the daily weather map in the hands of the general public at an early hour through the medium of the daily press. It is believed that efforts should be directed towards the reproduction of a legible map in the daily papers. It should contain the forecasts and other climatological data of importance to each community in which it is published. Efforts in this direction have been made heretofore, and with great success, for a limited period, but they have been spasmodic.

Newspaper rivalry aided in the reproduction, and also sometimes caused its discontinuance. Recent efforts to secure the publication of the maps in daily metropolitan prints seem to indicate that if the publication could be made exclusive, instead of general, some arrangement of value to the people might be consummated. But a monopoly for the reception of useful information from the Government of the United States can hardly be tolerated, even in thought. How, then, shall the daily forecasts be best utilized for and by the American people? Can they be so utilized by the Government supplying stereotypes at all the points where forecast maps are now published?

ADMINISTRATIVE WORK.

Material changes have been made in the methods of work of the central office. Executive work heretofore performed in a separate division of the office has been placed under the personal supervision of the chief clerk, in addition to his other duties. Work not executive has been subdivided and assigned to other divisions. These changes have been conducive to the prompt and systematic handling of business.

An increased number of high-grade salaries is needed to reward employees for faithful service and experience. At present it frequently happens that an employee, specially experienced in a particular class of work, can be promoted only by a transfer to other and untried duties, with the further disadvantage that the vacancy thus created must be filled by a new and inexperienced man. The regular classified observing force of the Bureau consists of twenty-seven local forecast officials, at $1,500 each per annum, and two hundred and seventy-six observers and assistants, at salaries ranging from $600 to $1,400 per annum. The number of local forecast officials is limited by law and the present number is below that needed. There is a constantly increasing demand for the services of these officials and the Chief of the Bureau earnestly recommends an increase in their number.

There has been made recently a readjustment and equalization of salaries of the general observing force, substituting for the complicated unclassified pay account incident to former military rank a classification more in harmony with the civil branch of the public service. Owing to the limited appropriation, this task was a difficult one. It has finally been satisfactorily accomplished and instead of forty-two grades or more, as under the old system, there are now but nine.

There are now in operation 159 regular paid observing stations. Two new stations were established during the current year and nine were discontinued.

PUBLICATIONS.

Several important and valuable publications have been issued by the Bureau during the current year, including: A Summary of International Meteorological Observations, by Maj. H. H. C. Dunwoody, U. S. Army, assistant chief of the Bureau; Report of the First Annual Meeting of the American Association of State Weather Services Coöperating with the Weather Bureau; A Report on the Climatology of the Cotton Plant, by Prof. P. H. Mell; A Report on the Forecasting of Thunder Storms during the Summer of 1892, by Inspector N. B. Conger; and The Climate of Chicago, by Prof. Henry A. Hazen.

The publication of the Monthly Review has continued throughout the year. Its purpose is the tabulation of current observations, enabling the officials of the Bureau and others to preserve and discuss the meteorological conditions that obtain from month to month. It also supplies a means of acknowledging the reports of some 2,500 voluntary observers, to each of whom a copy of the Review is furnished.

STATE WEATHER SERVICE.

The State Weather Service Division supervises 42 State weather services, covering the whole of the United States except Alaska. It also establishes and supervises all voluntary observations and forecast display stations, and the services in the cotton, sugar, and rice regions, and publishes the National Weather Crop Bulletin. The 2,500 voluntary observers forward copies of their records to the central stations of their respective local services for use in the preparation of the reviews published monthly. Many of these State reviews are of a highly creditable character and valuable in determining the climatic characteristics of the various States and Territories. For distributing weather forecasts and special warnings all available means have been utilized, and, while the number of stations supplied at Government expense by telegraph or telephone has been materially decreased during the year, the number of those to which forecasts, etc., are furnished at little or no cost has been largely augmented.

Full forecasts are now received at 1,622 stations, a reduction of 200 during the year; but nearly 5,000 places received them gratuitously, an

increase of over 1,000 in the same period. Plans now being perfected will, it is believed, increase the number of stations receiving forecasts without expense to the Government by 1,500 to 2,000 in the near future. A number of railroad companies are effectively coöperating with the Bureau in the distribution of forecasts by telegraph. It is believed that during the coming year it will be possible to extend the system to every community having interests to be benefited.

Observations of temperature and rainfall are daily collected by telegraph from 118 Southern stations, divided into 12 areas, the center of each area being selected with special reference to its cotton, sugar, and rice interests.

The National Weather Crop Bulletin is issued in Washington weekly during the periods of planting, growth, and maturing, and shows the temperature and rainfall for the week and season compared with averages for former years. The Bulletin also shows the crop and weather conditions of the previous seven days in each State or district. These statements are condensed from reports from over 6,000 special correspondents. The full text of the Bulletin is telegraphed by the press associations, and receives wide circulation. The State weather services, with the exception of Nevada, issue local weather crop bulletins, similar in character to the National Bulletin. Arrangements have recently been carried out for the public display of the Weather Crop Bulletin in about 130 towns of 5,000 or more inhabitants.

RECORDS.

A system of checks upon the accuracy of each observer is maintained, beginning with the telegraphic reports received twice daily by the translator. Later, when the manuscript observations are received, they are subjected to a further examination. It is gratifying to report that, with a few exceptions, the work has been highly creditable.

Several hundred transcripts of records of meteorological observations have been made during the year for use as evidence in courts of law, especially in cases relating to the transportation of perishable goods. The increasing demand for climatological data, bearing upon an infinite variety of subjects, bears testimony to the increasing confidence of the public in the work of the Bureau. A special climatological report, embracing the result of observations made during the calendar years 1891 and 1892, has been compiled, and is now in press. The report contains much new climatological data of interest and value.

INSTRUMENTS.

The mechanical excellence and efficiency of our instruments steadily improve, and as they attain greater perfection, so the accuracy of the data obtained will be increased. The barometers now in use at stations are, it is believed, in better general condition than ever before. The new standard pattern anemometer with aluminum cups is replac-

ing the old style of anemometer at stations as fast as possible, and every effort is made to obtain accurate records of wind velocity.

The policy of loaning meteorological instruments to voluntary observers and others to render reports therefrom has added greatly to the work and usefulness of this division without additional expense. This wide distribution of instruments is, no doubt, productive of great good to the general public aside from the value of the observations themselves, for every observing person who examines our standard Weather Bureau instruments and methods of observation is taught a higher appreciation of accurate results and what constitutes a first-class instrument.

The most important instrument developed during the past year is the improved normal barograph, which has been in operation and on exhibition at the Columbian Exposition.

This division has devoted much time during the year to the preparation and installation of the Weather Bureau exhibit at the World's Fair. Many favorable comments were made in reference to this exhibit not only by many prominent and professional men of our own country, but also by distinguished scientific visitors from abroad.

METEOROLOGICAL CONGRESS AT CHICAGO.

The Official International Congress of Meteorologists, which it was hoped would be held in Washington in August, was held at Chicago, August 21–24. Papers of great importance were presented from the leading meteorologists of the world, which the Bureau has undertaken to publish.

RECOMMENDATIONS.

There seems to be necessity for a closer coöperation with the weather service of Mexico, and to that end the Chief of the Weather Bureau reports arrangements with the director of the Central Meteorological Observatory, Sr. Mariano de la Barcena, for an international exchange of telegrams on terms similar to those in operation between the United States and Canada. The Mexican service is willing to deliver without expense, to our agent at the nearest point, certain information and receive in exchange from us certain data.

The need of full telegraphic reports from the Bahamas was clearly shown very recently by the disastrous hurricane of August 28. It is believed that if the matter were officially presented to the government of that colony the importance of an interchange of meteorological information would meet with favorable response.

This service continues to send daily cablegrams to the French Meteorological Bureau at Paris, containing marine data obtained from the logs of incoming vessels, the position of areas of highest and lowest pressure in the United States, and data from two selected stations in the Canadian maritime provinces.

A more efficient and satisfactory distribution of railway forecasts could be made if the postal clerks on mail trains were intrusted with the display of signals and made responsible therefor. This would require very little time on the part of the clerks, and the expense to the Weather Bureau would be reduced to a minimum.

DIVISION OF STATISTICS.

The Division of Statistics discharges duties distinct from each of the other divisions of the Department, and yet, directly or indirectly, illustrates the value and character of the labors of each of them, as the report of its chief thoroughly demonstrates. Its work touches all that relates to the economics of agriculture. Upon it devolves the duty to watch and report the conditions throughout the entire country likely to affect the growing crops, and also to observe in foreign countries which compete with us agricultural resources, conditions, and possibilities.

The purpose of its monthly reports is primarily to keep the farmers informed, as approximately as possible, of all matters having any influence upon the world's markets in which their products find sale. Its publications relate especially to the commercial side of farming—that is, to the purchase of material, the selling of crops, and all intermediate exchanges between the producer and the consumer. A monthly report upon the conditions of the principal crops of the United States is required by law, which also provides that the said report issue on the tenth day of each month.

It is of profound importance and vital concern to the farmers of the United States, who represent nearly one-half of our population, and of direct interest to the whole country, that the work of this division be efficiently performed and that the information it has gathered be promptly diffused. Earnest efforts will be directed to the attainment of the highest standard of efficiency on the part of this division in the performance of these arduous duties.

AGRICULTURAL EXPORTS.

The exports of agricultural products from the United States for the fiscal year ending June 30, 1892, attained the enormous figure of $800,000,000 in round numbers, being 78.7 per cent of our total exports. In the fiscal year following this aggregate was greatly reduced, but nevertheless attained the very respectable figure of $615.000,000, being 74.1 per cent of all American commodities exported. The value of the foreign markets to our farmers and to the entire population of the United States can, therefore, hardly be overestimated.

At present a review of our agricultural exports, with special reference to their destination, will show that in almost every line the United

Kingdom of Great Britain and Ireland absorbs by far the largest proportion. A few figures, showing exports of our principal agricultural products, will emphasize this very clearly.

Of cattle, the total exports aggregated in value, for 1892, $35,000,000, of which Great Britain took $34,000,000; and in 1893, $26,000,000, of which the same country took considerably over $25,000,000.

Of beef products of all kinds, our total exports for 1892 exceeded in value $31,000,000, of which $25,000,000 went to Great Britain; and in 1893, $28,000,000, of which Great Britain took $24,000,000.

Of pork products, the total exports for 1892 aggregated in value $85,000,000, of which Great Britain took $47,000,000; and in 1893, $84,000,000, of which Great Britain took $53,000,000.

Nearly the same average proportions prevail in breadstuffs and minor products, while in cotton they are even more conspicuous.

Our total exports of corn for 1892 were $41,000,000, of which $20,000,000 went to Great Britain; and in 1893 $24,000,000, of which $9,000,000 went to Great Britain.

Our total exports of wheat for 1892 were valued at $161,000,000; of this, Great Britain paid $68,000,000. For 1893 the total exports of wheat were of the value of $93,000,000; Great Britain took of this $58,000,000.

Of wheat flour, the total exports for 1892 were $75,000,000; to Great Britain, $47,000,000. In 1893 the total exports were about the same as for 1892, while Great Britain took $48,000,000.

The total exports of cotton for 1892 were $258,000,000; to Great Britain $146,000,000. In 1893 the exports of cotton were valued at $188,000,000; to Great Britain were sent $99,000,000.

These figures prove not only how large a proportion of our total agricultural exports find their way to Great Britain and Ireland, but also how very large a proportion of our total agricultural exports is made up of a comparatively few leading crops. It must not be forgotten that in the universal competition for enlarged trade constant efforts are being made, and will continue to be made, by other countries producing a surplus of agricultural products, to wrest from us the supremacy we now hold in supplying Great Britain and a few other countries that are not self-providing in such products; that many of these other countries are British colonies, and that, except as regards cotton, there are none of which we enjoy the practical monopoly. Moreover, we have been for many years pursuing a policy tending to deter the various nations of the world from becoming our customers, and, like the fertility of the soil, trade once lost or diverted is most difficult to regain, calling for a long period of careful management to atone for the consequences of even a short period of careless management. This is conclusively shown in the effects of the prohibitory laws passed in Germany and France and in some other European countries against our pork products, and maintained in force for about a decade.

Although these were repealed two years ago, and in spite of all the advertising given to the American hog by the discussions preliminary to repeal, we are still very far from having regained the trade in pork products which we had with Germany and France prior to the enforcement of their prohibitory laws. The lesson gained from the above facts and figures is, that the people of this country are to be much benefited by the diversification of agricultural exports and by their entrance to all the countries of the globe which it is in our power to supply with any product that the varied soil and climate of this vast country will enable us to grow at a profit. The extraordinary fluctuations in the prices of the crops composing our principal exports are often caused by the concentration of demand in comparatively few markets. This still further teaches the necessity of widening the foreign markets for our agricultural products.

To overcome impediments to trade, the plan of sending agents into Germany, Sweden, and other European countries to tell foreigners the value of Indian corn as human food was inaugurated. A reference to the export of corn before the commercial propaganda from the United States began their itineracy, and to the amount being exported at the present time, may be of value and suggestive.

The missionary labors in the food-consuming fields of Europe by the special agents of this Department, which the law provides for, have been extended, so that a thorough inquiry is being prosecuted as to why American meats are partially excluded; why American tobacco is not more demanded; why American wheat flour can not be more generally marketed in Europe; why cranberries are not sold there; why American wines are not called for, and why Europeans generally should not be consumers of American canned goods?

Some time hence a further report from the two agents of this Department in Europe now seeking markets for American products may help to solve the economic problems presented. But in case no solution comes from that source, the reason of the virtual closing of the markets for American products in some parts of the Old World may possibly be attributed to the high tariff duties upon all products and commodities which foreigners desire to sell in the markets of the United States. And thus the question will again be presented to the American mind: "Can any country shut *out* the commodities and products of other nations without shutting *in* a value equal to that of the things shut out?"

AGRICULTURAL IMPORTS.

A review of our agricultural exports prompts a consideration of our agricultural imports. This reveals a large value in our imports of agricultural products. The question then comes up whether some, perhaps much, of this great total of annual agricultural imports, aggregating in value some $350,000,000, ought not to be produced upon

our own soil, in proximity to those of our own markets, where this immense demand exists? And the truth is, it could and should be so grown.

The time will surely come when, under the favorable conditions of soil and climate which this country possesses, a very large share of agricultural products now imported will be raised by American farmers. Our large imports of hides, fruits, nuts, and wines, aggregating an average of over $60,000,000 annually, could all be produced in this country. A considerable share of the fibers, including wool and silk, and, no doubt, a large portion of the tobacco now imported, could also be produced in the United States. This is true likewise of sugar. Thus the overproduction of certain staples, the demand for which fluctuates greatly, might be avoided and our farmers be benefited by a larger number of available subsidiary crops. This also would increase the variety of our agricultural supplies in foreign markets and multiply the markets themselves.

These important considerations are sincerely commended to the attention of all who, either individually or in association, directly or indirectly, are engaged in the work of agricultural education; for upon them rests the responsibility of leading the way for progressive agriculture. All persons engaged in the work of agricultural education and experiment must hold steadily in view the inexorable economic facts that affect the production and disposal of agricultural products. American farmers must produce what the world wants. And the unrelenting truth that the relation of supply to demand is the sole regulator of value, and that it applies with equal force to all the products of the farm and of the factory, ought to be engraved upon the memory and reflected in the judgment and the plans of every farmer in the Union.

THE AGRICULTURAL DOMAIN.

There are in the United States more than 6,000,000 of farms. Upon them dwell more than 30,000,000 of the population of this Republic. Those farm dwellers furnish more than 74 per cent of the value of the exports of this country. This Department is, therefore, intended to be charged with great responsibilities and grave duties touching interests intimately associated with the lives, prosperity, and happiness of the whole people. And, as every citizen understands perfectly well that no architecture, no edifice, however symmetrical, beautiful, and perfect its superstructure, can be permanent and enduring except its foundations be solidly and well laid, so everybody knows that the successful perpetuation of the industrial activities of the American people is based, and possible only, upon an intelligent and fecund agriculture.

Promises of improved services to the farming interests by the Department in future, and even the recommendations of useful innovations relating to the detail of the work which confronts it, have been with-

held. in view of the statements already made as to its undefined duties, powers, and possibilities. A year from this time, it is hoped, after consultation with the Congressional committees and other representative forces which are endeavoring to educationally develop and define duties for this Department, that useful progress in the right paths may be truthfully reported.

Respectfully submitted.

J. STERLING MORTON,
Secretary.

SPECIAL REPORT

OF THE

ASSISTANT SECRETARY OF AGRICULTURE

FOR

1893.

SPECIAL REPORT OF THE ASSISTANT SECRETARY.

SIR: I have the honor to submit herewith a brief account of the origin, character, and control of the World's Columbian Exposition, together with a special description of the exhibit of the U. S. Department of Agriculture, its object and character; such a report having been made desirable, as it seems to me, by my appointment as Representative of this Department on the Board of Management of the Government Exhibit.

Very respectfully,

EDWIN WILLITS,
Assistant Secretary.

HON. J. STERLING MORTON,
Secretary.

THE WORLD'S COLUMBIAN EXPOSITION.

ORIGIN OF THE EXPOSITION.

For many years a general discussion in the press of the country, in Congress, and in other legislative bodies was carried on regarding the propriety of holding a grand international exposition to celebrate the four-hundredth anniversary of the discovery of America by Christopher Columbus. This discussion culminated in the passage of an act by Congress, approved April 25, 1890, entitled "An act to provide for celebrating the four-hundredth anniversary of the discovery of America by Christopher Columbus by holding an international exhibition of arts, industries, manufactures, and the products of the soil, mine, and sea, in the city of Chicago, in the State of Illinois."

CHARACTER AND CONTROL OF THE EXPOSITION.

It was thought that such an exposition should be of a national and international character, so that not only the people of our Union and this continent, but those of all nations as well, could participate, and that it should, therefore, have the sanction of the Congress of the United States. The exposition contemplated would cost a large sum of money. It was not thought best to pledge the national funds or the national credit to the enterprise. Three sources of revenue were proposed:

(1) so much of the national funds as should give the exposition an international character and should authorize the United States Government to be the medium of intercourse with other nations through its authorized agents, and to confer such supervision as would justify a feeling of security on the part of the exhibitors from foreign lands; (2) contributions to the enterprise from the city in which the exposition should be located; (3) the receipts from admission to its gates and from the concessions made to private exhibitors, and from the minor enterprises permitted within its grounds to facilitate the comfort, convenience, and success of the exposition.

To carry out the project a corporation was formed under the laws of the State of Illinois, recognized by said act of Congress, which was charged with the duty of constructing buildings, ornamenting grounds, and carrying on what might be considered the essential business of the enterprise. There was appointed also a National Commission, which, jointly with said corporation, should manage the Exposition; the expense of which commission, however, was to be paid by the National Government, these expenses being limited, in the first instance, to $1,500,000, including the building for the Government's own exhibit and for the cost of the exhibit itself. The magnitude of the enterprise as actually carried out may be comprehended from the statement made by the corporation November 7, 1893, when the Exposition was formally closed, that the total expenditures amounted to $25,540,537, and that the total receipts from all sources were $28,151,168. These expenses were those of the corporation alone, and did not comprise the $6,000,000 which had been spent by foreign governments, and the $6,000,000 by the various States, which made a grand total of $37,000,000 in addition to the money spent by the National Government and by private exhibitors.

There were 400 separate and distinct buildings on the grounds, exclusive of booths. The main exhibition buildings covered 150 acres, and 50 acres were covered by buildings erected by concessionaires. The largest building, the building devoted to manufactures and liberal arts, covered 30½ acres, and, including the galleries, furnished exhibit space of nearly or quite 40 acres—said to be the largest building under roof ever constructed.

It will be seen, therefore, that while this enterprise, for form's sake, was placed under the supervision of the National Government, the essential labor and nearly the whole of the expense devolved upon the Illinois corporation; and to the energy, self-sacrifice, and enthusiasm of the city of Chicago is due its marvelous success. Without question it exceeded in magnitude and splendor any exposition hitherto known in history.

The Exposition buildings were dedicated on the 12th of October, 1892, and from that time until the 1st of May, 1893, were open to the installation of exhibits. On May 1, 1893, the grounds and buildings were

opened to the public, but the general exhibits were far from complete, the Government exhibit being more advanced than any other exhibit on the grounds, being in such a state of forwardness as to appear to the ordinary visitor as complete.

THE GOVERNMENT EXHIBIT.

Aside from this nominal control through its National Commission, the United States had no interest and was in no sense a factor, except as an exhibitor. It was provided in said act that the Government should make an exhibit, as follows:

> SEC. 16. That there shall be exhibited at said Exposition by the Government of the United States, from its Executive Departments, the Smithsonian Institution, the United States Fish Commission, and the National Museum, such articles and materials as illustrate the function and administrative faculty of the Government in time of peace and its resources as a war power, tending to demonstrate the nature of our institutions and their adaptation to the wants of the people; and to secure a complete and harmonious arrangement of such a Government exhibit, a board shall be created to be charged with the selection, preparation, arrangement, safe-keeping, and exhibition of such articles and materials as the heads of the several Departments and the directors of the Smithsonian Institution and National Museum may respectively decide shall be embraced in said Government exhibit. The President may also designate additional articles for exhibition. Such board shall be composed of one person to be named by the head of each Executive Department, and one by the Directors of the Smithsonian Institution and National Museum, and one by the Fish Commission, such selections to be approved by the President of the United States. The President shall name the chairman of said board, and the board itself shall select such other officers as it may deem necessary.

The act further provided that a suitable building or buildings should be erected for the Government exhibits, at a cost not to exceed the sum of $400,000, and Congress appropriated from time to time an aggregate sum of $949,000 for the selection, purchase, preparation, arrangement, safe-keeping, installation, transportation, and return of such articles and materials as were embraced in these exhibits.

BOARD OF MANAGEMENT FOR GOVERNMENT EXHIBIT—ITS MEMBERS, ITS POWERS, AND ITS WORK.

Under the same act a Board of Management for the Government Exhibit was appointed, as follows: Chairman, Edwin Willits; representative from the Department of State, Chief Clerk Sevellon A. Brown; from the Treasury Department, Assistant Secretary Allured B. Nettleton; from the War Department, Maj. Clifton Comly, U. S. Army; from the Navy Department, Capt. R. W. Meade, U. S. Navy; from the Post-Office Department, Third Assistant Postmaster-General A. D. Hazen; from the Department of Justice, Special Agent Elijah C. Foster; from the Department of the Interior, Commissioner of Railroads Horace A. Taylor; from the Smithsonian Institution and National Museum, Assistant Secretary G. Browne Goode; from the Fish Commission,

Assistant Commissioner J. W. Collins; and from the Department of Agriculture, Assistant Secretary Edwin Willits.

Subsequent resignations and appointments to vacancies were made as follows: In the State Department, Mr. Brown was succeeded by W. E. Curtis, of the Bureau of American Republics, and he again by W. W. Rockhill, chief clerk; in the Treasury Department, Assistant Secretary Nettleton was succeeded by F. A. Stocks, chief clerk; in the Navy Department, Capt. Meade gave place to Lieut. Commander E. D. Taussig, U. S. Navy; in the Department of Justice, Special Agent Foster was succeeded by Cecil Clay, chief clerk; and in the Fish Commission, Mr. Collins was succeeded by Dr. Tarleton H. Bean.

This board so appointed became an independent board, having the exclusive power of conducting everything connected with the preparation, installation, etc., of the exhibits, the heads of the different Departments having no control over the management of the exhibits except in deciding what should be embraced in the Government exhibit from their respective Departments. The appropriations for the exhibit were made directly to the board, and the board accounted for the same directly to the Secretary of the Treasury. The board had its own chairman, who approved its vouchers in the name of the board. It appointed its own officers and agents and expended the money appropriated subject to no limitation except the approval of the Secretary of the Treasury. This is worthy of consideration, inasmuch as there seems to have been some misapprehension on the part of some of the heads of Departments. Under a ruling of the Secretary of the Treasury, even the detail of any of the Departmental force by a head of a Department required the approval of the board before the funds appropriated to the board could be charged with traveling or subsistence for such detail, on the ground that the board, being responsible for the money directly to the Treasury, should not have imposed upon it even by the head of a Department an employee it did not want and for whose expenses it did not desire to be charged.

Again, it will be observed that the exhibit was not to be ten separate exhibits managed by ten different representatives, but it was a single exhibit with ten branches, we may say, the money being appropriated to the board as a body and not to the different representatives of said board for the use of the respective Departmental exhibits. The accounts with the Treasury Department were carried on the books as accounts of the Board of Management of the Government Exhibit, and, while carrying out the duties imposed upon it relating to the Government exhibit, the board has invariably acted as a unit. For the sake of convenience, however, the board itself, by an understanding among its members, tentatively allotted to the representatives of the respective Departments a certain proportion of the funds appropriated to it, so that each representative might have some standard to work to and might know what to use within the line of the exhibit with

whose preparation he was nominally charged. By the courtesy of the board it was, as a rule, controlled by his judgment. In all cases, however, proposed plans of the respective exhibits were presented to the board for its approval, with estimates of their supposed cost. In some cases it was found necessary, especially where there was a conflict between two Departments desiring to exhibit a similar line, to call upon the board to prevent duplication and define the limits between them; and all through, from beginning to end, the board was supreme. The money appropriated still remained at the disposal of the whole board and was liable for the accounts properly incurred by any and all representatives. All appointments, even of the special workers in any Department, were made by the board on the nomination of a representative. The result is that all deficiencies, if any should exist in any one of the tentative allotments, will be made good by the board, and every obligation properly incurred by any representative will be liquidated so long as the appropriation is not exhausted, and the indication now is that there will be a considerable balance covered into the Treasury.

In all these respects the law was a departure from that authorizing the Government exhibit at the Centennial Exposition at Philadelphia in 1876, and at each of the subsequent expositions in which the Government has taken part. In all prior cases the money was appropriated directly to the Departments, and there was no board except such a one as was organized by executive order or by mutual coöperation. The new plan had its advantages as well as its disadvantages. It made the whole exhibit a unit with comparatively few duplications of exhibits, and it made the whole arrangement more systematic, efficient, and complete. On the other hand, it detracted in a measure from the independence and individual zeal of the respective Departments, which caused some friction, but this was happily adjusted by the courtesy and general good feeling of the members of the board.

The board, after its appointment, convened promptly, completed its organization, elected F. T. Bickford its secretary, and in time chose J. Fred. Aytoun its chief clerk and W. I. Adams its disbursing clerk, and subsequently appointed such other officers and agents as were necessary to execute the duties imposed upon it.

SCOPE OF THE GOVERNMENT EXHIBIT.

Under the law the buildings were to be completed and dedicated on the 12th day of October, 1892, and said Exposition was to be opened to visitors not later than the 1st day of May, 1893, and to be closed not later than the 30th day of October, 1893. The board, therefore, after its organization proceeded to consider the scope of the Government exhibit. It was met at the threshold by the grave uncertainty as to the amount of money which would be at its disposal.

The first appropriation included in the act was only $200,000, to be

divided between this board and the National Commission, and was intended only for the first year's expenditures. It soon became manifest that the commission would spend, if permitted, the whole of it, and by a singular phraseology the wording of our appropriation was such that we could spend but little. The result was a division by the Secretary of the Treasury between conflicting claims, by which the National Commission was allotted $160,000 and the Board of Management $40,000 out of the first appropriation. Subsequently the phraseology of our appropriation was so modified as to enable us to carry out effectually the duties imposed upon us, and the appropriations thereafter were separated so that each board knew definitely the funds given to it.

The board called for estimates from the representatives of the respective Departments of the amount necessary, in their judgment, to the preparation and exploitation of their respective exhibits. The aggregate estimates amounted to over $2,000,000. It was manifest that Congress would not respond to such an amount. The best guide we had to determine the amount we ought reasonably to expect was the experience at Philadelphia. There the aggregate appropriation for the Government exhibit was $600,000, to fill a building that cost $80,000. The installation of that exhibit was primitive as compared with the more recent ones. The art of display had materially improved, and to make a display and exhibit along more recent lines would require, to lift it above disgrace, at least $1,000,000, especially as Congress had expressed its sense of increased expense by authorizing the construction of a building or buildings at a cost of $400,000. We determined, therefore, to plan our exhibit on the basis of $1,000,000, and to ask Congress for that sum. It resulted in an aggregate of appropriations, as before stated, of $949,000. Taking $1,000,000 as a basis, we tentatively allotted that amount among the different Departments according to the percentage agreed upon, so that each Department might project its plans accordingly.

EXHIBIT OF THE U. S. DEPARTMENT OF AGRICULTURE AT THE WORLD'S COLUMBIAN EXPOSITION.

FUNDS ALLOTTED TO THE DEPARTMENT.

The amount tentatively allotted to the Department of Agriculture by the Board of Management from the aggregate of appropriations, and which we were led to expect, was $150,000, or 15 per cent of the expected $1,000,000. But Congress in its wisdom, and at the last moment, cut down the appropriation by more than $50,000, leaving the Department to carry out the plans already formulated and approaching completion with $7,500 less than had confidently been expected. Moreover, in the same act Congress further diverted to specific purposes $9,500 of the sum remaining. A further unanticipated loss to the allot-

ment was the result of some miscalculation in the office of the Supervising Architect of the Treasury. The estimates made in that office for the buildings to house the exhibits included a structure for the display to be made by the Weather Bureau, but after the exhibit of this branch had been brought nearly to completion, the board was informed by the Supervising Architect that his means were exhausted. It was too late to recede, and the allotment was made to suffer in consequence a further loss of $6,000. The aggregate of these drafts upon the allotment is $23,000. Fortunately, the allotments to other branches proved to be sufficiently liberal, and the law proved sufficiently elastic to permit the transfer of the funds necessary to complete and administer the exhibit, and I take this opportunity to acknowledge the courtesy of my fellow members of the board in devoting their surplus to the necessities of the branch I have the honor to represent and for the credit of the whole.

The following is a classified list of the expenditures of the several bureaus, divisions, and special exhibits:

Expenditures of bureaus, divisions, and special exhibits of the U. S. Department of Agriculture at the World's Fair.

Divisions, bureaus, and special exhibits.	Purchases, salaries, travel, printing, subsistence, and other expenses directly charged.	Proportion of general expenses of installation.	Total
Division of Vegetable Pathology	$2,750.57	$1,100	$3,850.57
Division of Entomology	7,163.53	2,700	9,863.53
Division of Microscopy	2,382.04	1,200	3,582.04
Division of Pomology	2,363.86	1,200	3,563.86
Bureau of Animal Industry	11,978.19	4,000	15,978.19
Office of Fiber Investigations	917.97	2,000	2,917.97
Division of Forestry	5,330.57	3,000	8,330.57
Division of Chemistry	6,274.41	3,000	9,274.41
Office of Experiment Stations	19,346.12	3,000	22,346.12
Division of Botany	2,630.18	1,200	3,830.18
Division of Illustrations	657.72	500	1,157.72
Division of Ornithology and Mammalogy	8,106.53	3,500	11,606.53
Division of Statistics	668.00	200	868.00
Division of Records and Editing	300.00		300.00
Cotton	2,098.02	1,500	3,598.02
Wool	1,297.15	500	1,797.15
Silk	41.30		41.30
Tobacco	5,622.97	2,500	8,122.97
Cereal	7,234.25	2,000	9,234.25
Weather Bureau	7,944.33	3,500	11,444.33
Total	95,107.71	36,600	131,707.71

NATURE OF THE DEPARTMENT'S EXHIBIT.

Agriculture is that branch of human industry which is least susceptible to benefit from the incorporation of individual interests or the aggregation of capital. Lacking the opportunities created by other leading interests for continuous public display and advertisement, it seeks more frequently than they such advantages as may accrue from periodical fairs and expositions, and has come to be known as the

branch from which most is expected and whose functions are most available in such gatherings.

Its conditions in this regard were recognized by Congress in the law providing for the American display at the last and greatest of the foreign expositions (French Exposition Universelle de 1889), agriculture being the only industry specially provided for in the appropriations for that enterprise, while popular recognition has been evinced from the earliest times in our history by county, State, and national fairs, more frequently devoted exclusively to agriculture than to all other interests combined.

Notwithstanding these fundamental conditions, however, it will doubtless be admitted that the task devolving upon the Department of Agriculture, in connection with the World's Columbian Exposition, was more difficult, as it proved to be somewhat more costly, than that placed upon any other branch or institution of the Government. Being that from which most was expected, it was at the same time the one having in comparison the least in the form of "articles and materials" from which to draw. At the French Exposition referred to, the Department of Agriculture was made the agent and intermediary of the American producer; and it had for its field of display whatever was deemed worthy of all American farm products and the manufactures therefrom. At the World's Columbian Exposition the American producer appeared in his own behalf, and the Department was limited by law, as interpreted, to the illustration of its own specific functions. Inasmuch as these consist chiefly in experimentation and in the testing of theories and development of methods, the performance of its share of the work required by law involved the creation of the means throughout. How thoroughly and successfully this was done is best shown by the reports of the gentlemen in immediate charge of the several subdivisions, which are appended, and which present in detail the particulars of that part of the exhibit prepared by each division or branch of the work. These will also serve to make manifest the functions of the Department, but it will not be out of place first to consider them briefly in a general and comprehensive way.

FUNCTIONS OF THE DEPARTMENT.

The primary conditions of agriculture are soil and climate. Hence these are appropriately fundamental subjects for consideration by the Department of Agriculture. Then follow the consideration of noxious insects and diseases which affect the product. After these would follow the broad consideration of all matters in any way tributary to an intelligent comprehension by those engaged in agriculture of the vicissitudes of and the means of its successful promotion. As stated before, a large portion of the work of the Department is experimentation, which leaves nothing in its wake except the data and conclusions which form the basis of reports, comparatively little with which to

illustrate the functions. Hence every exhibit, or nearly all the exhibits, had to be created to illustrate these functions. How this was carried out in most cases will be shown by the specific reports from the divisions. There is no report, however, from the Seed Division nor from the tobacco or cotton and wool exhibits. The Department itself produces neither of these commodities, though it makes, or should make, a special study of them all. It had, therefore, on hand no sufficient quantity of either that could in any way illustrate its work, and the effort was made to secure such a collection as should illustrate, so far as material objects could, the character and basis for departmental consideration and study.

Ever since the organization of the Department it has been charged with the purchase and distribution of new and valuable seeds and plants, the object being to distribute to localities to which they might be adapted improved varieties capable of increasing the quality and amount of the product. It has made great repute in the intelligent purchase and distribution of these seeds and plants. This made, of course, the subject of soil and climate a primary study, determining where to purchase and where to distribute. It is a conceded fact that in the purchase of seeds or plants in the locality where they produce at their best and in the distribution of the same to localities to which they are adapted, there will result a large increase in product.

THE CEREAL COLLECTION.

It was the purpose of the representative of the Department on the Board of Management to make as comprehensive a collection as he might be able to do from all parts of the world, principally from North America, of all the leading staples, with full reports as to the soil in which they were grown, the time of the year in which they were planted and harvested, and the products per acre.

In pursuance of this plan he collected or caused to be collected nearly 2,500 samples of wheat, ranging from the Peace River region in the northwestern territory of Canada, from about the sixtieth degree of north latitude, then running south, a large proportion of the wheat-growing States and counties of the United States, through Mexico, Central America, Colombia, Peru, and Chile, making the most comprehensive collection of that product ever brought together, and which, with the detailed reports which have been carefully preserved, will form the basis for the future study of the effect of soil and climate in its widest distribution, and, so far as the United States is concerned, to its almost minutest details, including, as it does, the product in every distinctive State and locality. Wheat was the cereal whose widest distribution was considered. Then follow oats, mainly limited to the United States, with 1,200 samples, and corn, 1,600 samples; rye, 450 samples; barley, 409; buckwheat, 250; miscellaneous, 250. These samples were all carefully hand-picked and weighed, so that the report

shows the actual weight per bushel of each sample. This test showed a very great variation in weight, and formed a factor in considering the effects of soil and climate on the same variety. It was not intended that this magnificent collection should exhaust itself with the mere exhibit, but that it should form a basis for future study by experts, to be followed by a comprehensive monograph on the distribution, varieties, care, and culture of each of said series, by which it might be determined where was the best locality for its highest and best production.

COLLECTIONS OF TOBACCO AND WOOL.

The same purpose was sought to be carried out in the collection of the tobacco, of which there were some 1,500 samples collected from ten States, showing a magnificent display of the products in nearly every tobacco-producing county in these States, an examination of which showed in a marked degree the effect of climate and soil upon the varieties produced, and the collection should form the basis of an exhaustive monograph by a thorough expert in the care, culture, and varieties of tobacco.

Of wool there were over 1,500 samples, 100 of which came from foreign countries and the remainder from every wool region in the country.

THE COTTON EXHIBIT.

Of cotton there were between 1,400 and 1,500 samples from nearly every cotton-growing county in thirteen States and Territories. Samples were obtained also from Africa (Congo), Peru, Egypt, India, and Russia; type samples from cotton exchanges of Liverpool, Havre, Bremen, New York, New Orleans, Memphis, Savannah, Charleston, St. Louis, Galveston, Mobile, and Houston; also, bales of Egyptian, Persian, Indian, Sea Island, and so-called American cotton, the last two being furnished by the Memphis Cotton Exchange. This subject was recognized in its comprehensiveness as of such importance that the committee on awards found it necessary to ask permission to include it in the scope of its consideration in making up the data which would form the basis of its report on cotton at the Columbian Exposition. While there were many bales of cotton in the producers' exhibit, both in the State buildings and in the great Agricultural Building, which included the exhibits of personal and State exhibitors, it was found when they came to consider the exhibits, that the data were comparatively meager. They did not cover one-quarter of the ground comprehended in the Department exhibit. The examination of our exhibit by experts showed a marvelous variety of fibers as they were manifestly modified by the soil and climate of the respective localities and that it would form an unquestionable basis of a comprehensive study of cotton as to the effects of soil and climate on variety.

WORK OF THE SPECIAL AGENTS.

The exhibit of wool was collected and prepared under the supervision of Edward A. Greene, of Philadelphia, the president of the National Wool-growers' Association, and under the advice of Hon. John T. Rich, now governor of the State of Michigan, a member of the National Wool-growers' Association; that of tobacco under John M. Estes, of Stoughton, Wis.; that of cotton, under Alfred B. Shepperson, of New York, editor of Cotton Facts, an authority among cotton producers and manufacturers, also secretary of the subcommittee of the United States Senate investigating the subject of cotton. These gentlemen were all experts, recognized as such in their respective lines, and worked with zeal as special agents in their respective lines, and I hereby tender them my thanks for the intelligence and energy and coöperation manifested by them. The cereal exhibit was collected and prepared under my personal supervision, with the assistance of Mr. Philip Walker, my chief special agent, and Mr. William F. Hubbard, one of the special agents employed in the work of the preparation and installation of our Departmental exhibit.

DESIRABILITY OF COMPREHENSIVE MONOGRAPHS.

In conclusion of this branch of the subject, the only regret I have is that my plan was too comprehensive, and from present appearances the result will not be adequate to the time, thought, and money engaged in its preparation. Unless followed by comprehensive monographs the objects sought will be in a large measure lost. It will be seen that these monographs would cover the whole cereal exhibit, also those of wool, tobacco, and cotton. To these should also be added a consideration of the fiber exhibit, which is more particularly described in the reports of the exhibits of the respective divisions, which follow.

THE DISPOSITION OF GOVERNMENT EXHIBITS.

Under the law the Exposition closed the 30th day of October, 1893, and the formal proceedings of closing occurred on that day, though under the Illinois law the general exposition did not close until the following day. Immediate steps were taken for the packing and return of the Government exhibits to their respective Departments. A considerable portion of the exhibit of the Department of Agriculture was loaned to the Field Columbian Museum, of Chicago, a perfect inventory thereof made, and receipted for by the museum, to be returned on call at any time to the Department of Agriculture. Said inventory and receipt have been filed in the office of the chief clerk of the Department. A portion of the cotton exhibit was sent to the Augusta (Ga.) Exposition on the condition that it be sent to the Department after the close of that exposition, all expenses to be paid by them. A por-

tion of the corn exhibit was loaned to the Salem (Mass.) Corn Festival, with the like understanding.

The herbarium of the Division of Botany was loaned, one-half to the Minnesota State Normal School and the other half to the Delaware Natural History Society, on the same conditions as the loan to the Columbian Museum. On like terms the charts and maps shown by the Division of Statistics were deposited with the Political Science Department of the Chicago University. The remainder of said Department exhibit has been returned to Washington. It was intended to sell at Chicago most of the laboratory tables and a portion of the glass and cases and other material which might not be of immediate service in the Department, but the bids therefor were so exceedingly low that they were not accepted, and nearly everything was loaded on cars and returned to the Department, there being practically no charge for transportation, as that had been provided for by the payment of the shipment to Chicago at the full rate one way. The loan of a large number of the empty cases with the plate glass, etc., to the Columbian Museum avoided the necessity of such sale or of their return to the Department at the present time, where there is now neither space nor use for them.

The large tree (*Sequoia*) from California, which was exhibited by the Department of the Interior, was tendered to the Department of Agriculture and accepted with hearty thanks, and it has been shipped to Washington to be set up on the grounds of the Department of Agriculture. If properly set up it will form one of the most striking curiosities in the city of Washington.

PRACTICAL SUGGESTIONS.

After three years of work in the supervision of the preparation, installation, etc., of our exhibit and a careful survey of the situation, this being my first experience in connection with any exposition of note, it is but just to myself, and of possible benefit to others upon whom may devolve similar duties, to give a concise statement of the mistakes made. A very full report follows of the exhibits of the several bureaus and divisions, so that there may be, in case of any future exposition, full information of the line followed and the materials exhibited by this Department at the World's Columbian Exposition. There was in the present case no beaten track to follow and but few suggestions were obtainable. Nothing was on record to serve as a guide in the quest of what should or should not be done. Therefore mistakes were made, and they are now set forth for the benefit of the future.

(1) No one man should have been the representative of the Department on the board and its chairman, while still retaining an active participation in the duties of an office so exacting as that of Assistant Secretary of an important Department. The labors thus entailed were such as properly should have devolved upon three persons.

(2) From lack of acquaintance with what might be termed the impulse of an exposition crowd, several thousand dollars were spent for exhibits and illustrations in second stories of the buidings; that effort was found to be absolutely without value. The average sight-seer will not climb stairs to see an exhibit or listen to a lecture. The second story or galleries of the great Manufactures Building were so slimly attended as to call for bitter complaints from exhibitors.

(3) Too much was spent on cases—most of which were made to fit the exhibits. Comparatively few were of uniform size or of such character as would permit of a contract in bulk with some manufacturing company at possibly half the cost to the Department. The result was that the cases were all constructed by a force of carpenters and painters and glaziers, and while the exhibit gained much in repute by having a variety in the style, form, and size of the cases, and was therefore more satisfactory to the chiefs of the divisions, the extra cost involved did not receive adequate compensation by the enhanced interest of the sight-seers.

(4) Even though it were thought best to construct cases to be adapted to the exhibit, these should be made at home, in close proximity to the Department, so as to be under the constant supervision and direction of the representative whose time would be devoted exclusively to the preparation of the exhibit. As it was, comparatively few of the cases were made in Washington. In February the Chief Special Agent proceeded to Chicago with a small force of carpenters with the hope that lumber could be secured there as cheap if not cheaper than in Washington, and that any further force of carpenters needed could be had at practically the same rate, with the accruing advantage of a saving in transportation of the cases and the possible better adjustment of them by building them in place on the space allotted to this Department. It happened that the weather from February to the first of May was very unfavorable; the Government Building leaked; the grounds were stormswept and it was rainy and muddy; lumber was difficult to get; all material sold at enhanced prices; the source of supply was the city, 8 miles away; the demand for labor was so great that double wages were paid, and this oftentimes for inferior work. The result was that the installation of the exhibits cost probably from one-third to one-half more than any one anticipated. Any possible successor in similar work will find it wise, therefore, to be guided by our experience and do all that is possible to be done at home.

(5) Too much was paid for glass; that is, there was more plate glass than was necessary. Some marked exhibits should have plate glass, but at least half of them might with equal effect, so far as the attraction to the general public is concerned, have been provided with cheaper glass.

(6) Too much money was spent for labels. The labels to a large

extent took the place of the guide whose duty might be to point out and exploit the exhibit. But the great mass of the people never come down to details. By them the general effect only is considered. Comparatively few stop to study an exhibit. And while according to the museum standard an exhibit is not complete except it be thoroughly labeled, my observation and experience are that an exposition need not approach the standard of the museum, which is almost exclusively educational in its scope and character.

(7) Too much money was spent on photographs and enlarged figures and objects on wall maps. Some of the choicest pictures, which cost the most money, were not noticed, much less studied. There was enough to absorb the attention on the ground floor in the range of ordinary vision.

(8) There were many other directions, too numerous to mention, in which expenditure might be avoided without impairing in any great degree the attractiveness of the exhibit in popular estimation.

After having thus frankly set forth mistakes made I may be pardoned for expressing a feeling of pride in the symmetry, the unity, and completeness of the exhibit as a whole and in detail. It had a purpose running all through it. Its idea was educational, and had a significance that was highly appreciated by the intelligent visitor who stopped to study its scope. It has commanded the respect of experts in the line of the functions sought to be illustrated, and it has met the commendation of so many people competent to judge such matters in their several parts, that though my high standard was not attained and my purposes as to ultimate results have not been fully realized, I rejoice that I was considered worthy of projecting and carrying out an enterprise that so fully illustrated the functions of the Department which I have served to the best of my ability for nearly five years and from which my relations are soon to be sundered.

ACKNOWLEDGMENTS.

I can not well express my thanks to my superiors, Secretary Rusk and Secretary Morton, for their hearty encouragement and active assistance in every way possible to be rendered by them, to the chiefs and members of the bureaus and divisions, and to my special agents and the employees under me for their aid during the execution of this enterprise imposed upon us by Congress.

It is proper, also, to here acknowledge our indebtedness to the following-named persons, who contributed handsomely to the success of the Department exhibit by well-selected contributions of various products, manufactures, models, pictures, etc.:

Mr. Charles U. Shepard, Messrs. Jones & Warr, The Atlantic Transport Line, The Burton Car Company, Street Cable Car Company, S. B. Steers & Co., Chickasaw Iron Works, Smith Scale Company, Memphis Cotton Exchange, Fr. Jac. Andres, Miss Ashe, J. W.

Labouisse, James F. Wenman, The Q. and C. Company, The Hamilton Manufacturing Company, P. Rascoe, Dayton Last Works, Henry Disston & Sons, Gage & Co., Christian Nonnenberger, Smith & Stevens Manufacturing Company, S. N. Brown, The Acme Manufacturing Company, Messrs. Parke, Davis & Co., and many others whose names will be found on the record who contributed to the success of the cereal, wool, tobacco, and cotton exhibits.

Detailed accounts of the exhibits of the several bureaus and divisions of the Department follow:

BUREAU AND DIVISION EXHIBITS.

EXHIBIT OF THE WEATHER BUREAU.

The exhibit consisted of a completely equipped meteorological observatory, provided with facilities for receiving daily telegraphic weather reports from the regular stations of the Bureau, and for preparing and printing from these, in accordance with most approved methods, a daily weather map for general distribution.

This exhibit, being installed in a special building, afforded upon the roof proper exposure for thermometers, hygrometers, anemometer, wind vane, rain gauge, and sunshine recorder; these instruments being connected by electrical circuits with recording apparatus located in the exhibit room on the ground floor, and giving there, under the inspection of visitors, continuous records of all the important meteorological conditions.

The distinctive features of the exhibit are classified and briefly described as follows:

Weather-forecasting and map-printing.—The regular telegraphic weather reports for the 8 a. m. observation received at the Chicago station were taken to the Exposition by messenger at about 10 a. m. of each day (Sundays excepted). These reports, about 125 in number, were translated before the visitors and the various elements of data entered upon standard manuscript weather maps, the same as used at the central office. A copy of the weather map, showing isobarometric and isothermal lines, was prepared, from which, by means of a pantograph, a lithographic transfer was made on a reduced scale and placed upon a lithographic stone, from which finished copies of the lithographic weather map were struck off in such number as was required. The edition, according to the attendance at the Fair, varied from 300 and 400 to about 3,000 a day. The printing of this map was provided for by a special contract with the Goes Lithographic Company, of Chicago, who furnished the necessary presses and appliances at their own expense. The printing of the maps generally began about 12.30 p. m., each map presenting the weather conditions as shown by the observations at 7 a. m., central time, and containing a full synopsis of the weather conditions for the preceding twenty-four hours, with a forecast for the next thirty-six hours applying to the vicinity of Chicago.

Instruments and apparatus.—The more important instruments and apparatus exhibited are enumerated as follows:

(1) Instruments in operation: Standard triple register, Weather Bureau pattern, giving a continuous record of the direction and velocity of the wind and the duration of sunshine and cloudiness; anemo-cinemograph, recording the momentary fluctuations in wind velocity; tele-thermograph, recording in the exhibit room the temperature of the free air in the instrument shelter on roof of building; weighing rain guage, giving a continuous record of the amount, the rapidity, and time of occurrence of rainfall; recording aneroid barometer and normal mercurial barograph; and in addition, for the purpose of more lucid exhibition and explanation of some of the more complicated instruments, there were in operation on short circuit a tele-thermo-

graph, exhibiting the mechanisms by which conditions of the temperature are transmitted and recorded electrically at a distant point; also, a weighing rain guage, actuated by dropping of water drawn from a faucet, showing the manner in which rainfall is recorded electrically at a distance. Other forms of recording rain gauges were also in operation in a similar manner.

(2) Instruments not in operation: This classification comprises a large collection of instruments mostly of a nonrecording character, but all of standard pattern and construction, and exhibited in a manner to show visitors the correct methods of employing these instruments, and arranged to facilitate the explanation, to those interested, of the general principles of their operation and use. Among these were standard instrument shelter, completely equipped with thermometers, hygrometers, whirling psychrometer, thermograph, etc.; standard anemometer and wind-vane supports, rain guage and supports, standard mercurial and aneroid barometers, thermometers, special thermometers for determining water and soil temperatures, dew point and humidity apparatus, radiation thermometers, nephoscope, photographic and electrical sunshine recorders, and apparatus and appliances employed in comparison and standardizing of thermometers, etc.

Climatic and meteorological charts.—This exhibit comprised a collection of 42 charts, 20 by 30 inches, drawn by hand on engraved base maps of the United States, and showing the normal or average, climatic condition throughout the entire country, compiled from the Weather Bureau observations beginning in 1871, and, in some instances, including older observations.

Miscellaneous.—Under this head is classed a large collection of photographs of lightning flashes, cloud effects, frost work, spray, mountain effects, etc. The Bureau is indebted to Prof. William M. Davis, of Harvard University, for the loan of a large number of these photographs from the collection belonging to the university, and also to Mr. H. P. Curtis, of Boston, for the similar loan of many beautiful photographs of frost and cloud effects from his own private collection. Messrs. Alexander McAdee and A. J. Henry also contributed cloud and lightning photographs. Photographs of lightning, printed on an enlarged scale, were kindly presented to the Bureau by Mr. W. N. Jennings, of Philadelphia.

A complete file of all the publications of the office, consisting of bulletins, pamphlets, etc., was displayed, and arrangements made so that parties specially desirous of any particular copies could receive the same on application.

Exhibit of the Bureau of Animal Industry.

The exhibit of the Bureau of Animal Industry was illustrated by the two branches into which the work of the Bureau is divided, one scientific and the other practical. The scientific embraced the study into the causes, effects, prevention, and cure by scientific means of the various contagious and parasitic animal diseases, the laboratory methods pursued in bacteriological researches, and a presentation of the propagation, growth, and appearance of the various germs causing this class of diseases. The practical included the humane treatment of stock and the prevention of the spread of the contagious animal diseases by executive regulations.

Scientific work.

The scientific exhibit in detail consisted of (1) working bacteriological and biochemic laboratories with all the apparatus usually employed in such researches; (2) the chemical products of the growing germs of tuberculosis and glanders with instructions for use in diagnosing these diseases in doubtful cases where ordinary methods fail; (3) a refrigerating case containing the germs causing the various contagious diseases of animals, growing on the substances on which they are usually cultivated; (4) colored illustrations of these germs highly magnified; (5) lesions or effects caused by them upon the various susceptible animals, shown by the subjects

themselves mounted, models of affected organs, and natural specimens of each preserved in alcohol, exhibiting both the healthy and the diseased state.

The various parasites infesting the domestic animals were exhibited in alcohol, and their effects on the organs and their life histories were illustrated by drawings and explanations.

Practical work.

What may be called the practical part of the exhibit embraced the work of eradicating pleuro-pneumonia from the United States, the subject being graphically presented by a globe delineating the origin, chronological spread, and present geographical distribution of the disease, the proclamation of the Secretary of Agriculture that the United States was free from pleuro-pneumonia, and the blanks, forms, orders, instructions, record books, and other paraphernalia used in the work.

The prevention of the spread of Texas fever within the United States is accomplished by the enforcement of the regulations governing the movement, either on foot or by rail, of cattle from the district permanently infected with this disease. A map of the United States, showing the boundaries of this district, was accompanied with the regulations forbidding the movement of cattle on foot during the season of the year when the disease can be spread by this means. The method adopted for the prevention of the spread of the disease by cattle in transit by rail was illustrated by a model of the Kansas City stock yards, where the isolation of such cattle liable to spread the disease is secured by the use of pens exclusively devoted to the yarding of such dangerous cattle, thus preventing contact with those from the uninfected district; accompanying this were the regulations governing such transportation and requiring disinfection of yards and cars before they are used for cattle from the uninfected district.

The system pursued for preventing the introduction into the United States of contagious diseases of animals from foreign countries was illustrated by a model of the United States quarantine station for neat cattle, situated at Garfield, N. J., where animals of certain kinds imported into this country are held for observation for a period of ninety days previous to allowing them to enter the commerce of the country.

The microscopic inspection of meats was presented by displaying the instruments, report blanks, record books, etc., used, together with photographs exhibiting the manner of use, and models of beef and hog quarters showing how the carcasses are tagged and sealed with the stamp of the Department indicating inspection.

The tagging of cattle for interstate and export trade was illustrated by photographs and a model of a tagging chute with cattle passing through and being tagged by the officers of the Bureau.

The modern methods of transportation of animals was shown by models of a steamship and several stock cars of the latest patterns.

The subject of horseshoeing was presented in detail, both scientifically and practically. The exhibit included models and natural specimens showing the development of the horse's foot, the ordinary diseases to which it is subject, distinguishing those which can be beneficially affected by a special manner of shoeing or by the use of shoes of special designs from those which can not be thus benefited; shoes of special designs were exhibited adapted to certain irregularities, malformations, etc., of the feet and legs, having in view the correction of such defects; also samples of racing shoes worn by the famous trotters when they made their best records.

The exhibit was supplemented by a number of photographs of parts of the Bureau's work which could not be otherwise illustrated, such as the loading and unloading of cattle from steamships, methods of handling meats in the English markets, some famous individuals of the different breeds of thoroughbred live stock, scenes at stockyards and abattoirs illustrating various steps in the process of the ante-mortem and post-mortem inspections, the slaughtering of animals, and the tagging, stamping, and packing of meats and meat products.

Exhibit of the Division of Chemistry.

The exhibit of this division consisted of a complete agricultural laboratory, on a working scale. The chief features of the equipment of the laboratory were the following:

A complete equipment for the analysis of sugar-producing plants. The apparatus for this purpose consisted of a small comminutor suitable for the pulping of sugar cane, sorghum, sugar beets, etc. Connected with this pulping machine was a press for the extraction of the juices from the pulp. The apparatus for the analysis of portions of sugar beets consisted of various forms of rasps for the production of a fine pulp for instantaneous diffusion. In addition to these machines all the standard types of apparatus for taking small portions of beets for analysis, without destroying their germinating powers, were exhibited.

In connection with this apparatus was a complete set of polarimetric apparatus. This apparatus comprised all the types of polarimetric apparatus from the small shadow instrument with single quartz plate, suitable for the examination of ordinary sugar solutions, to the most accurate and scientific instrument for determining specific rotatory powers. These instruments were equipped with all modern improvements, together with a new lamp for providing a constant monochromatic flame, which it is believed is the best yet devised for this purpose.

Apparatus designed for the analysis of foods. The apparatus for the determination of nitrogen consisted of a complete combustion apparatus, with a mercury pump, and the most modern form of battery for the estimation of nitrogen by the moist combustion process.

Apparatus for the recovery of waste alcohol. The amount of alcohol used in agricultural analyses is often very large, and a reliable method for its recovery and reduction to standard strength is extremely desirable. This was secured in the form of a continuous still, with all of its appliances, having a capacity to recover from alcohol waste from 2 to 3 gallons of 96 per cent alcohol per hour.

The apparatus for grinding cereals and preparing them for analysis was also an important feature of the exhibition, over 600 samples of cereals having been prepared for analysis during the progress of the work.

Other features of the laboratory were complete apparatus for the analysis of soils, fertilizers, and other matters connected with the agricultural industry.

There were exhibited, in cases, typical forms of apparatus not in use and certain results of the work of the division in the production of sugar and starch, and in the investigation of the adulterations of foods.

The actual work of the laboratory during the progress of the Exposition was chiefly the examination of food products on exhibition, for the executive committee on awards. The exact number of samples examined is as follows: Wheat, 266; barley, 59; buckwheat, 10; corn, 23; rye, 27; rice, 26; oats, 70; flours, 48; cornmeal, 1; bran middlings, 2; olive oils, 128; miscellaneous, 49; beers, 219; sugars, 454; wines, 249; butter fat, 9; hops, 36; starches, 24; lards, etc., 30; glues, 17; condiments, 22; rums, 11; yeasts, 2; brandies, 4; grape juice, 1; total 1,687.

In all cases the samples for analysis were brought to the laboratory labeled by number only, so that the chemists in charge of the work could not possibly have any bias in regard to the conduct of the analytical operations.

From the 1st of July, when the active work for the board of awards commenced, until the close of the Exposition six chemists were actively employed.

Exhibit of the Division of Entomology.

The exhibit of the Division of Entomology was designed to illustrate the work done in the investigation of the history of injurious insects, in devising suitable remedies to prevent their injuries, and in building up and maintaining a large national collection of American species and also of exotic insects for purposes of comparison. The intimate connection of the Department of Insects of the U. S.

National Museum with the Division of Entomology, the former being in large measure the custodian of the insects collected by the Department of Agriculture, justified the Entomologist, as honorary curator of the said Department in the National Museum, in using this last feature as a part of the exhibit of the Department of Agriculture, and to avoid duplication he, with Prof. Goode's approval, confined the Museum exhibit to the exhibition of the characteristics of families of American insects.

The display of the Division of Entomology may be paragraphed as follows:

Of insects injurious to agriculture some 602 special exhibits were made, each of which was an object and pictorial epitome of the life history of a single important injurious species, with samples of the injury done by it, its enemies and parasites, directions for remedies and preventives, with references to sources of fuller information, these last being principally to Government and State reports, to which the farmer is more likely to have access. These exhibits were grouped according to the plants and animals affected, and related to orchard, field, and garden crops, the parasites of domestic animals and household pests, together with a collection of cases illustrating injuries by insects to forest trees. Supplementing both were certain prominent and interesting displays of an entirely novel character, the leading features of which were wax models of the host plants to draw attention to and illustrate their insect enemies, which latter were displayed either as enlarged models or in the natural state alongside. While a considerable number of plants were thus modeled, the three most important, as representing characteristic economic plants, were cotton, Indian corn, and hop.

The portion of the exhibit which more particularly illustrated the National Museum collection consisted of a number of cases representing the systematic and biologic collections in different orders, not, however, as complete series, but as samples taken from the actual collection to illustrate the methods employed in the arrangement of systematic and biologic series and to give visiting entomologists and others an insight into the present status of the National Collection. With this section, but not belonging to it, the same being secured and prepared at the expense of exposition funds, were included a showy exhibit of insects, chiefly from South America, intended to give some idea of the nature and extent of the insect fauna of the tropical regions of this hemisphere; also a special exhibit of the golden-rod (*Solidago*), with the insects which affect or frequent it, arranged in a display about a wax model of the plant. The Solidago was selected as being the most distinctive and widespread of the floral forms which add beauty to our autumn scenery, and a plant also of great entomological interest from the large number of insects which either breed on it or are attracted to its bloom. This, with the foregoing tropical insect display, was designed to form the showy portion of the exhibit and to appeal to the love of the beautiful, in contrast with the remainder of the exhibit, which was scientific and educational in its scope.

A display of silk insects was made, representing the more important native and foreign Lepidoptera the larvæ of which spin silken cocoons, and which are or may be of commercial value as sources of silk. The life history of several species was illustrated, and in some instances specimens of raw silk were shown.

What may be called a professional exhibit was a collection of apparatus used by entomologists in the collection of insects and in their mounting, preservation, and rearing. Of chief interest among these was the series of devices and methods for rearing insects, comprising a large variety of cages and breeding jars of all sorts, many of which were fitted with wax models of plants and with insects, showing the exact methods followed in this line of the work of the division.

The principal insecticide preparations which have proved of value in the work of the Entomologist in the prevention or destruction of injurious insects were exhibited in two series, the first including important substances not covered by patent, some 80 examples being shown, of which about a dozen fulfill all ordinary requirements.

To make the exhibit more complete a second series of the more valuable patented articles was shown, the latter being exhibited without comment, for the reason that all practical needs are met by the substances shown in the first series. In this section also were exhibited the important nozzles for the application of liquid insecticides and a few of the leading insecticide machines, with special prominence given to the knapsack sprayers.

A file of the official entomological publications issued by the National Government, comprising both the work of the Division of Entomology and of the U. S. Entomological Commission, was displayed, with sample copies also arranged for convenient reference. An exhibit was made of a series of illustrations of North American insects, representing figures appearing in the reports of the Entomologist on the insects of Missouri, from his own drawings when official entomologist of that State, and also illustrations from the United States Government reports, mainly of the U. S. Department of Agriculture, including illustrations of insecticide machinery. A series of maps and charts was shown, illustrating the range of important injurious insects on this continent, and a number of large solar prints illustrating the classification and development of insects in the different orders. There were also charts of special injurious species, with views representing the practical application of insecticides and of insect depredations; also of interiors of the rooms of the Division of Entomology of the Department of Agriculture, the Department of Insects of the National Museum, and views of the Insectary of the Department.

Assistants of the division were detailed from time to time during the summer to take charge of the exhibit and expound it to visitors, and a special catalogue was prepared to supplement the exhibit by giving such information as could not be given in the labels or indicated by the objects themselves. This catalogue was on hand for distribution to interested parties during the latter half of the Exposition.

Exhibit of the Division of Ornithology and Mammalogy.

The exhibit of the Division of Ornithology and Mammalogy consisted mainly of graphic illustrations of the work done in each of the two branches of research conducted by that division, namely, the geographic distribution of mammals and birds and the economic study of the food habits of the various species.

Geographic distribution of mammals and birds.

Three large models were prepared to illustrate the distribution of animals and plants in broad belts or zones, the boundaries of which are fixed primarily by temperature. The most important of these was a mountain slope (20 feet long and 10 feet high), on which mounted specimens of characteristic mammals and birds were so assembled as to bring before the eye at a glance the successive faunas of different elevations, thus showing all the life zones of North America above the tropical.*

This was supplemented by a large topographic relief model of the area covered by the Death Valley Expedition, one of the biological surveys conducted by the division. This area, comprising about 100,000 square miles in California, Nevada, Utah, and Arizona, contains the highest elevations and deepest depressions in the United States, and is of the utmost interest to the physiographer and biologist. On this model, and on an adjoining relief map of the United States, the various life zones were shown in different colors. To render the picture more vivid, the models were accompanied by enlarged photographs of desert scenery, with characteristic animals and plants.

The work on geographic distribution was still further illustrated by about 60 maps of the United States, colored to show the areas inhabited by individual species

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*Of this mountain slope a reviewer has said: "From a scientific standpoint it is doubtless the best single exhibit in zoölogy shown at the fair."

and genera of mammals, birds, reptiles, and plants. These maps are made in the following manner: A red spot is placed on the map wherever the species is actually known to occur. (In the case of birds, only breeding records are used.) After the range of the species has been pretty well outlined by compiling the published records, the uncertain parts of its boundary are visited and corrected by actual field work. Then the area covered by the spots is washed in by some one personally familiar with the physiography of the region. By combining large numbers of such maps a true faunal map of the whole country is obtained.

Economic relations of species.

The exhibit of the economic relations of species consisted of a number of separate groups of mammals and birds known to be beneficial or harmful from the standpoint of the agriculturist, each handsomely mounted and surrounded by appropriate accessories in the way of environment and food supply, so as to present an important chapter in the life history of the animal. For instance, there were 5 groups of ground squirrels, each comprising about half a dozen animals, mounted in different positions and engaged in different pursuits—some in the act of ravaging grain fields, others capturing grasshoppers, others still on the lookout for enemies from the mouths of their burrows or from their retreats among rocks or logs.

A small colony of prairie dogs in one of their villages or "dog towns" showed the animals at home. Some were digging and eating the roots of plants; others were scampering about, while one stood as sentinel on the highest mound—a funnel-shaped elevated rim surrounding the mouth of the burrow. The corner of an adjacent wheat field, tangled and trampled, indicated their destructiveness in cultivated regions.

A group of pocket gophers was so arranged as to enable the observer to see the animals at work in their subterranean passages, one of which led to a potato hill where a gopher was engaged in gnawing a tuber; another gallery contained the nest and a storehouse of food. Several of the little mounds of earth thrown up by these animals and known as "gopher hills" were shown above the surface.

A prairie wolf or coyote struggling to overcome a sheep which he had by the throat was one of the most striking groups.

A number of skunks, comprising both the common species and the little spotted skunk of the South and West, showed the animals engaged in their favorite occupation of hunting and capturing mice and insects.

In addition to those already named there were groups of native cats (wild cats, lynxes, and ocelots), minks and weasels, raccoons, opossums, rabbits (both jack and cottontails), and meadow mice or voles.

Besides the mammals, there were no less than fifteen groups of birds, each teaching an important lesson in the economy of the species. One showed a number of crows in a cornfield, some pulling the newly sprouted corn; others devouring grubs. Two cuckoos feeding upon destructive caterpillars among the fresh foliage and blossoms of an apple tree illustrated the value of this bird, which not only subsists mainly on insects, but is particularly fond of caterpillars so hairy that other birds will not eat them. A small flock of cedar birds or waxings, feeding on innocent looking little leaf beetles on the drooping branch of an elm, formed a very attractive group and at the same time emphasized the usefulness of this bird; for the insect in question is the elm-leaf beetle which in some cities has stripped the elm completely, and it belongs to a family of insects the members of which seem to be distasteful to other birds.

One of the most instructive groups was that of the bobolink, a handsome and harmless songbird dearly beloved in the North; a destructive pest warmly hated in the South. Both chapters in its life history were shown in the same case: At one end the male and female in full breeding plumage were seen near their nest, partly concealed in the tall grass and flowers of a Northern meadow; at the other end a small flock in autumn plumage were gorging themselves in a field of ripening rice on a Southern plantation.

One of the villainous traits of the English sparrow was brought out by a group of the little thieves engaged in denuding the branches of a peach tree of its beautiful blossoms—each flower an embryo peach.

The accessories of all these groups—grass, leaves, flowers, birds, and insects—were reproduced as faithfully and artistically as possible, for the purpose of arresting attention and compelling recognition of that union of beauty and utility so characteristic of bird life, but so commonly overlooked.

The importance of bird life to the farmer was further shown by collections arranged in table cases and representing the food of various species of birds, each item of food carefully labeled. Thus one collection was devoted to the food of the crow; the various articles going to make up his diet at different seasons of the year being shown by actual specimens of seeds, fruits, insects, mice, cray-fish, and other animals, the samples of grain and insects being particularly numerous.

Groups of carefully mounted hawks and owls in the act of killing or eating some animal habitually preyed upon, gave a clue to the gain or loss which each is likely to bring to the farmer. This was supplemented by a particularly instructive exhibit of the food of hawks, comprising a series of stuffed skins of the birds, mice, squirrels, and other animals that have been actually found in the stomachs of the various species. A novel feature of the exhibit of the food of owls consisted in numerous "pellets" or "castings" disgorged by birds of prey, and composed of the bones, teeth, scales, shells, hair, and other indigestible matter.

"As a graphic lesson in the relations of birds to man," writes a reviewer in a scientific magazine, "the exhibit of the Division of Ornithology and Mammalogy has probably never been equaled. Here are groups which tell their own story so plainly that the most casual observer, attracted at first by their beauty, can not leave without at least some knowledge of the facts they are designed to explain."—(Auk, October, 1893.)

Exhibit of the Division of Botany.

This exhibit was designed to illustrate three principal lines of work conducted by the Division of Botany, namely, (1) the herbarium, (2) forage experiments, and (3) native medicinal plants. The exhibit was planned by Dr. George Vasey, but his death early in March, 1893, necessitated its execution by others.

The herbarium.—This consisted of a case occupying a wall space of 8 by 12 feet, containing a collection of 5,000 specimens of plants, each mounted upon a sheet and properly labeled. These sheets were placed in folders of manila cardboard systematically arranged upon the shelves. The list of contents of each shelf, stating the genera and family contained therein, which were in plain view from the outside through the glass doors of the case, facilitated the prompt location of any plant which it was desired to consult. The National Herbarium at the U. S. Department of Agriculture in Washington, which is arranged upon the same plan, illustrates the natural vegetation and plant resources of the United States, and is used as a reference collection in correspondence and in questions brought up by the work of any branch of the Department.

Native medicinal plants.—The collection of 300 native medicinal plants by Parke, Davis & Company, of Detroit, consisted of specimens put up in the form in which they are commercially known, *i. e.*, flowers, leaves, stem, or root, and arranged on shelves, in glass jars of uniform size. Each bore a label stating its Latin, popular, and pharmaceutical names, the part used, and its properties. Many of the jars were accompanied by a mounted and framed specimen of the plant. This collection illustrates the great importance of our native plants in the drug supply of the country, and emphasizes the need of an accurate scientific investigation of their real properties.

Forage plants.—The exhibit of forage plants was made up of bunches or small sheaves, each representing a different species, grown either at the forage experiment station conducted by the Department of Agriculture, at Garden City, Kans., or at

the Mississippi State Agricultural Experiment Station, where work of a similar nature had been carried on under the direction of the Department. Among the plants exhibited were specimens of Hungarian brome (*Bromus inermis*), a grass which has proved far superior to any other so far known in the subarid region; switch grass (*Panicum virgatum*) and Colorado blue stem (*Agropyrum glaucum*), two native grasses of the Great Plains, which have proved successful under cultivation in the same region; and several grasses and clovers which have been introduced into the Gulf States with most gratifying success.

EXHIBIT OF THE DIVISION OF VEGETABLE PATHOLOGY.

In preparing this exhibit the object kept in view was to show in as practical a manner as possible the methods of work of the division and the relation of this work to the agricultural and kindred industries of the country. The first part of the exhibit was a series of models, paintings, and photographs showing the general effects of a number of important diseases upon fruits, grains, and other useful crops. It was intended that this portion of the work should appeal directly to the eye of the practical man, showing him at a glance, for example, just how an apple appeared when affected by the scab fungus or a grape leaf looked when attacked by the downy mildew. To increase the value of this part of the exhibit there was added from time to time, as the season advanced, fresh specimens of the diseased plants themselves, collected by agents of the division in various parts of the country.

Following the models, paintings, etc., were a number of colored charts and maps illustrating the distribution of various diseases in the United States.

Then came carefully prepared drawings showing, on a greatly enlarged scale, the parasitic fungi causing the diseases illustrated by the models, paintings, specimens, etc. These drawings showed the manner in which each particular fungus attacked, developed upon, and finally killed or injured its host plant. Thus the branching threads of a fungus, which to the naked eye would be wholly invisible, were shown, growing through and between the cells of a plant, breaking down the tissues and producing the external effects illustrated by the models. To add to the value of the exhibit there was kept constantly on hand a full line of laboratory apparatus used in the study of plant diseases. A trained specialist was also present to point out the methods of work and the bearing of this work on practical questions of interest to farmers, fruit-growers, and others.

From the investigation as carried on in the laboratory, the observer was next directed to the field work, where the methods employed in fighting the various fungous pests were shown. First a full collection of fungicides or remedies for fungous parasites was exhibited, not only the complete fungicide being shown, but the various ingredients as well. Accompanying this exhibit was one showing the various machines designed and used by the division in applying the fungicides. Finally there was shown a series of large photographs illustrating the effects of the treatments recommended by the division. These were from actual experiments in orchards, vineyards, potato fields, etc., and illustrated the marked contrast between treated and untreated portions, the object being to bring out as clearly as possible the practical value of the work.

To summarize briefly under heads, the exhibit in the main was as follows: (1) Models, paintings, photographs, and living plants, illustrating the external characteristics of various diseased crops; (2) colored maps and charts showing the distribution of the more important diseases in the United States; (3) drawings illustrating the life history of the fungi, whose external characters were shown by the models, etc; (4) laboratory apparatus and methods of using the same in the study of the fungi (in charge of assistant); (5) fungicides or remedies for plant diseases; (6) apparatus for applying the fungicides; (7) photographs showing some of the results of the work of the division in preventing the diseases of plants.

Exhibit of the Division of Pomology.

The exhibit of this division contained five leading features, viz: (1) Collection of fruit models; (2) cultural exhibit of strawberries; (3) collection of wild and cultivated nuts; (4) colored illustrations of fruits; (5) methods of recording and describing fruits.

The collection of fruit models contained nearly 1,000 specimens of about 625 varieties of fruits grown in the United States, representing 40 native and introduced species and numerous hybrids.

These models are facsimile representations in wax of the fruits selected for modeling, and were prepared under the direction of the Pomologist by G. B. Brackett, of Iowa. In preparing this exhibit the points aimed at were to present in such form as to permit of convenient comparison, (1) typical specimens of the leading varieties of our more important fruits; (2) specimens of the leading varieties from localities differing in latitude, soil and climate, showing the variation in the size, form, and color of the same variety when grown under varied environment.

Though this collection did not contain all the varieties known to American fruit-growers, it is believed that it included the most important ones. The collection was frequently referred to by the judges on fruits in the department of horticulture, in settling disputed questions concerning the identity and nomenclature of varieties. It is probable that it thus exerted a beneficial and far-reaching influence upon the nomenclature of American fruits.

The cultural exhibit of strawberries consisted of representations in wax, of bearing plants of three varieties of this fruit. They were arranged in a case under appropriate labels to show the single-hill and matted-row systems of culture which prevail in different parts of the country, and which are practiced to secure different desired results by strawberry-growers.

The collection of wild and cultivated nuts grown in the United States consisted of more than 300 packages. These represented 30 species, native and introduced, including many named and cultivated varieties of the walnut, chestnut, hazel, pecan, shellbark, and others. The specimens were so displayed as to show, in many instances, the thickness and cracking quality of the shells, as well as the general size, form, and color of the nut, these characteristics being regarded as of much importance in varieties intended for commercial cultivation.

The exhibit of colored illustrations of fruit consisted of water-color paintings selected from the collection in the office of the Pomologist.

They covered a wide range of species and varieties and were intended to show the usefulness of this method of preserving the characteristics peculiar to different fruits, so that they may be available for examination and reproduction long after the originals have perished.

To illustrate the methods followed by the division in recording and describing the fruits received for identification, a sample page from the journal of specimens received was shown, with samples of the descriptive blanks and index cards relating to the specimens noted on the same.

Exhibit of the Division of Forestry.

The exhibit of this division was displayed under the following six principal heads or classes: (1) Forest botany; (2) forest technology; (3) timber physics; (4) forest culture; (5) forest conservancy; (6) forest literature.

(1) *Forest botany.*

Of the 425 or more arborescent species indigenous to the United States—which may be reduced to 330 by exclusion of the tropical and subtropical accessions found only on small areas on the Florida coast and along the Mexican border—250 of the

more important ones were displayed. This was done systematically by a forest botanical collection, genera or families being grouped together on separate panels, the center of which contained small sections of wood (8 inches high and 2 inches thick) with the bark attached, partly polished, showing the appearance and character of the wood, and bearing a label giving botanical and vernacular names, field of botanical distribution on a small map, and description of the tree and its uses.

Surrounding this central part, the botanical characters of the species exhibited were displayed in closed glass cases (12 by 17 inches), containing dried herbarium specimens of foliage, flower, and fruit, arranged so as to facilitate a comparative study of the species. As a further aid to such a study, 328 colored plates of North American forest trees were exhibited in 19 swinging frames; 53 large photographs illustrated the typical habit of growth of some of the more important species, and 11 maps showed the general distribution of forests in the United States and of some of the important genera.

To indicate the study of physiological problems which occupy the forester's attention, a few specimens of peculiarities and teratological phenomena seen in forest growth were added, such as cypress knees in dissection, natural ingrafting of branches, cohesion of trunks, conductivity of lignified tissue sufficient to support a pine several years after complete girdling, etc.

Finally, as a basis for study from commercial as well as from botanical and forestry points of view, a monographic display of 20 important commercial timbers was made, namely, 10 coniferous and 10 deciduous trees. The material for each was placed in monster frames made of sections of the mature trunk of the respective trees themselves with the bark on. The interior, divided into 4 compartments, the glass cover, separated by mullions cut from small saplings, displayed in successive order a folio map showing the geographical range of the species; a label giving the vernacular and botanical nomenclature with full synonymy and economic description of the tree and its wood; photomicrographic illustrations of its wood structure; a panel of botanical specimens, including a branch with fruit or flowers, seed and seedlings; a panel of wood sections, transverse, radial, and tangential, being large veneer sections backed with zinc; cross sections of one large and several smaller trunks and various samples of commercial rough lumber; the whole forming a complete life history of each tree.

Forest technology.

Under this head lack of space prevented more than mere indications of some minor uses; most prominent and attractive among which was the exhibit of ornamental woods in the shape of a pagoda, in which a number of foreign and native kinds were artistically combined in veneer, paneling, and inlaid work. The pagoda rested on 12 veneered columns, each carried by a pedestal of 4 smaller columns. The center piece of the plafond and 4 lanterns, made of veneer sections laid out in French-window fashion and illuminated by electric lights, served to bring out color and texture of the various woods.

Pressed wood, a substitute for the more costly ornamental carving, was exhibited in models of various kinds in a frame (this exhibit and the pagoda being kindly loaned by the Spurr Veneer Company, of Boston). Samples of carriage and wagon builders' rough and finished material, including turned and bent woods; samples of shaved wood plates; nested boxes and measures; rough and manufactured spool stock; truss blocks and wood parts of trusses, tanners', carriers', and shoemakers' tool handles and implements, as well as handles of other kinds, were grouped artistically, to call attention to the variety of uses and adaptation of various kinds of woods, all of the materials having kindly been furnished by the manufacturers.

Wood type, showing the adaptability of various hard-grained woods, such as beech, maple, dogwoods, cherry, etc.

The use of wood pulp was shown in samples of heavy paper and in its application to the manufacture of indurated fiber ware in progression from the raw material (spruce wood) to the finished article (buckets, etc.).

The use of wood for upholstering and packing material was shown by samples of commercial excelsior.

Two of the more important by-products of the longleaf pine were specially illustrated. The Acme Manufacturing Company, of Wilmington, N. C., supplied samples of pine wool from the leaves of longleaf pine showing the gradual change from the leaf to the clean fiber, and woven articles, bagging, matting, carpets, and rugs, superior in wearing quality and not affected by moisture or vermin. The extensive turpentine industry, furnishing the largest amount of by-products coming from the forest (some $8,000,000 to $10,000,000 annually), was completely illustrated by 25 trunks, bled for from one to five years, taken from an Alabama turpentine orchard, with tools and appliances used in the ordinary wasteful method of boxing, and, for comparison, the better methods used in France were elucidated by illustrations and descriptions. Living seedlings, saplings, and larger trees of the species, together with photographs of the orchard, the distillery, etc., the original packages of resin and turpentine, and a stand displaying some 40 samples of various grades of crude and refined products, rosins, turpentine, pitch, tar, varnishes, heavy oils, etc., completed the picture of one of our most interesting forest industries.

(3) *Timber physics.*

Under the caption of United States Government timber tests, as extensive a display of methods adopted by the Division of Forestry in developing this branch of forestry as the limited space permitted was made. Six large drawings showed the ground plan of the timber-testing laboratory and the various testing machines at the Washington University, St. Louis, Mo., where the mechanical tests are carried on. Series of test pieces—120 samples—which had been subjected to various strains (cross-breaking, crushing endwise and across grain, tension, and shearing), including pines and oaks, were displayed with records attached, ranging from columns and beams 16 to 18 feet in length to the small shearing compression pieces of a few inches in length.

The method of collecting and labeling test material was explained by cards and record sheets, as well as the method of physical examinations of the test material, which are designed to discover the structural reason or verification of deficiencies or excellencies in quality. Various instruments, including a xylometer used in determining specific gravity of woods, constructed by Mr. F. Roth, one of the division force, and excelling in simplicity, rapidity, and accuracy of working, were exhibited; also, some of the results of the work. The most interesting of these was a comparative study of the wood of longleaf pine, bled and unbled, which had led to the important discovery that bled timber is in no way deteriorated by the process. The original material that had served for the determinations and record of chemical and physical analysis was shown.

A papier maché model, greatly magnified, of the structure of pine wood, together with comparative drawings of the structures of various species of the same, served to indicate the work in the direction of structural analysis of the material.

(4) *Forest culture.*

A correctly named collection of seeds, by which to verify and control those purchased for distribution, was displayed on an octagonal column 15 feet high, topped off with an artistic cone of pine cones, the seeds of 190 species of economically important forest trees being placed under glass covers, while the terraced base arranged for living plants displayed 150 coniferous trees ranging from the germinating seedling to the 5-year-old plantlet.

To indicate forest culture in the field, the model of a tree-planting machine in working order, capable of plowing furrows and completely planting 20,000 2-year-old seedlings in a day, most useful for the reforestation of plains and prairies, was shown.

The forestry school of Zurich, Switzerland, had kindly furnished material to illustrate the methods employed in ascertaining the effect of varying degrees of thinning upon the remaining growth, and other questions of forest management. Lack of space permitted the installation of only a part of this interesting exhibit, showing the careful and systematic plans and bookkeeping. Some photographs from the Sihlwald, near Zurich, showed the result of careful forest management, while publications from the forestry school and forest departments testified to the activity in forestry matters displayed by our sister Republic.

(5) Forest conservancy.

To furnish a proper conception of the long time it takes to produce timber of dimensions such as we are now cutting, a section of white oak 6 feet in diameter was exhibited, which showed by the record of its annual rings that it was a seedling when Columbus discovered America. A semicircular chart placed on the face of the section was laid off in decadal lines corresponding in contour and position to the rings of growth produced during each period, and coincident with these lines were noted important civil, political, and other historical events as they had occurred during the life of the tree, thus graphically bringing before the beholder the long period of life required for useful forest growth. For the sake of comparison the reverse side of this section displayed cross-sections of smaller trees, illustrating the comparative diameter accretion in various species grown under various conditions of soil and climate.

A display of metal railway ties and wood-saving devices in railway construction embodied some of the information laid down in Bulletin No. 4 of the division. Besides some 25 different types of metal ties, full sized or in models, used on some 30,000 miles of railroad in various parts of the world or as yet awaiting trial, there were shown wooden ties impregnated by various preservatives, and, for comparison, such as had not been impregnated and used for stated times; also spikes, bolts, and screws of various construction, made to obviate injury to the wood fiber in fastening the rails, tie plates to serve the same purpose, superior splice bars, and braces to obviate the shock at the joints.

A series of drawings, by Mr. E. E. Russell Tratman, gave details as to the most important metal ties.

The effect of forest destruction upon soil conditions and waterflow, and the expensive and laborious works necessary to repair the damage when the forest cover has been removed, a lesson to our people on forest conservancy, was shown in a series of photogravures from the Swiss mountain districts, accompanied by descriptive text.

The attempt at a more conservative forest policy by the United States Government with reference to the public timber domain found expression in a large wall map, showing the location of the newly made forest reservations (sixteen in number), comprising some 18,000,000 acres; the map in addition showed the relative density of forest growth in the various States.

A large artistic water-color emblem of the American Forestry Association, founded in 1882 for the purpose of advocating a rational forest policy, and a collection of arbor-day proclamations, issued by various governors of States, with programmes of arbor-day festivities and other arbor-day literature, illustrated some of the agencies by which the attention of our people has been directed to the subject of forestry.

(6) Forestry literature.

A forestry library aggregating in round numbers 100 volumes, among which the publications of the Division of Forestry form no inconsiderable part, formed an

instructive exhibit of the progress made in this direction in the last fifteen years. A catalogue of the library of the division, comprising all the best works in the English, French, and German languages, together with an index to the journalistic literature having a bearing on the subject, made in the Division of Forestry, was also displayed, furnishing the forestry student ready means of becoming acquainted with the subject and its literature.

THE COÖPERATIVE EXHIBIT OF THE OFFICE OF EXPERIMENT STATIONS AND OF AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The coöperative exhibit of agricultural colleges and experiment stations was designed to be a popular representation of methods and results of agricultural education and investigation in the United States. It was prepared, installed, cared for, and explained under direction of this Department, acting in coöperation with committees of the Association of American Agricultural Colleges and Experiment Stations. Congress, by specific act, required the Board of Management to include in its exhibits an exhibit of the agricultural colleges, and set apart $8,000 of our funds for that purpose. By the courtesy of the Board of Management of the Exposition the exhibit was installed in the southwest corner of the Agricultural building, and occupied about 8,500 square feet of floor space. It was divided into three main divisions, (1) the exhibit of the Office of Experiment Stations and college and station laboratories, prepared under direction of the Office of Experiment Stations; (2) the collective exhibit of different branches of experiment station work, prepared under direction of a committee of the Association of Colleges and Stations—Dr. H. P. Armsby was chairman; (3) the collective exhibit of different departments of agricultural colleges, prepared under direction of the executive committee of the Association—Maj. H. E. Alvord was chairman.

The collective exhibits of the colleges and stations were divided into a number of alcoves, each illustrating a special line of work, and the exhibit in each alcove was collected by a college or station officer selected by the committees. While the individual exhibits were intended to represent different features of college and station work rather than different institutions as a whole, credit was given as far as practicable to the institutions or individuals furnishing these exhibits.

The exhibit was not intended to show the work of different institutions or to illustrate the things which would be of especial interest to the professional educator or scientific investigator, but to show to the average visitor at the Exposition the ordinary methods and some of the more striking results of college and station work. The institutions for agricultural education, and especially those for experimental research, having been so recently established in most of the States that the great majority of our people have not had an opportunity to personally inspect their operations, it seemed advisable that the collective exhibit of these institutions at Chicago should be made a means for popular instruction in this line.

That portion of the coöperative exhibit prepared under direction of the Office of Experiment Stations consisted of (1) an exhibit of the work of the office and (2) college and station laboratories in operation.

Exhibit of the work of the Office of Experiment Stations.

In this exhibit an attempt was made to show the methods of preparation of the principal publications of the office—the Experiment Station Record and the Card Index of Station Literature. For this purpose the exhibit included the station publications abstracted in a single number of the Record, the copy as prepared for the printer, proof sheets in galleys and pages, and finally the completed pamphlet. In a similar way the different stages of editing, printing, packing, and mailing the card index were shown. Appropriate labels explained the more important steps in the different processes. The title-pages of the different publications issued by the office

were displayed in frames. The mailing list and the completed card index were shown in small cabinet cases. The library work of the office was illustrated by bound volumes of the publications of the experiment stations and this Department, and of the Rothamsted Experimental Station in England, and by other publications giving results of investigations in agricultural science. Maps were used to show the location of the agricultural colleges and experiment stations. Photographs of the past and present directors of the experiment stations were arranged on the wall space, and the buildings, laboratories, class rooms, etc., of the different institutions were illustrated by photographs in wing frames. There was also a bust of Hon. Justin S. Morrill, of Vermont, author of the two acts of Congress granting financial aid to the colleges of agriculture and mechanic arts, and a life-size portrait of Hon. William H. Hatch, of Missouri, author of the act of Congress establishing agricultural experiment stations in all the States and Territories.

Laboratories in operation.

This part of the exhibit consisted of four working laboratories, (1) a college chemical laboratory, (2) station chemical laboratory, (3) botanical laboratory, and (4) zoölogical laboratory. The purpose was to show in these laboratories such operations as are commonly carried on in experiment station work or for the instruction of college students. Comparatively simple processes which could be readily explained to the visitor were selected, and these were repeated from day to day. The laboratories were in charge of experts detailed from different colleges and experiment stations.

The college chemical laboratory.—This laboratory was equipped with demonstrator's desk, with gas, water, filter pumps, waste, and flue, student desk, and such apparatus and chemicals as are ordinarily used in the college laboratory. Particular pieces of apparatus were a water bath, drying oven, balances, large sulphuretted-hydrogen apparatus, spectroscope, and a combustion furnace used in making determinations of carbon, hydrogen, and nitrogen. A striking feature of this exhibit was a large glass still for the distillation of water.

The station chemical laboratory.—This was fitted up with such appliances as are used at experiment stations in making chemical analyses. One of the special features of this exhibit was the Babcock machine for determining the fat in milk. The gravimetric method of determining fats was also illustrated. The Kjeldahl method for determining nitrogen was demonstrated and analyses were made from time to time. Among the special pieces of apparatus were an improved balance, specific gravity balance, an oil bath used for heating substances to a higher temperature than could be secured in a water bath, drying oven for expelling the water from substances, various forms of fat extractors, apparatus for milk analysis, apparatus for the analysis of water for sanitary purposes, apparatus for artificial digestion, apparatus for sugar analysis (including spectroscope), a mercury pump for creating a vacuum, set of hydrometers, burettes, and a platinum distilling apparatus.

The botanical laboratory.—This laboratory contained materials and appliances illustrating different lines of experimental work in botany. For systematic botany there were tools and boxes for collecting plants, microscopes and other appliances used in the identification of species, and a select herbarium showing the way in which specimens of plants are preserved and mounted. Photography as applied to botanical work was illustrated by means of a dark room, cameras, and other photographic apparatus, one special piece being a camera stand devised by Prof. Lamson-Scribner, of the Tennessee station. To illustrate histological methods and work, a number of compound microscopes and their accessories, microtomes, reagents, mounting materials, etc., were provided. Physiological botany was illustrated by a case of fine pieces of apparatus from the laboratory of Prof. J. C. Arthur, of Purdue University. Among the pieces of apparatus shown in this case were auxanometers, potetometers,

respiration apparatus, assimilation eudiometers, root-pressure apparatus, root cage, thermometers for taking temperature of fleshy organs, clinostats, and a centrifugal apparatus for revolving germinating seeds. The processes involved in seed testing were illustrated with different kinds of germinating apparatus, in which from time to time seeds of various kinds were germinated. Experimental sand and water cultures were shown. There was also a model of the experimental plant house at the Massachusetts State Station.

Zoölogical laboratory.—This included special exhibits in three lines—entomology, bacteria in the dairy, and oyster culture.

The entomological exhibit included a complete outfit for a station laboratory devoted to the study of insects. Besides this apparatus, some of the results of station work in entomology were exhibited. The purpose was to show (1) the means used for collecting and preserving insects—nets for collecting, bottles for killing, pins for mounting, blocks for spreading, and boxes for displaying or preserving insects; (2) means for studying insects—dissecting tools, lenses, microscopes, reagents, staining fluids, and preservatives; (3) methods of breeding insects in boxes, bottles, or cages, with illustrations of the way in which records of observations are kept; (4) the use of photography in illustrating insect injuries and peculiarities of structure; (5) the arrangement of cases for museum purposes so as to show the insects in their different stages, the injuries which they cause, and the means for their repression. This exhibit was collected by Prof. J. B. Smith, of the New Jersey Station.

In the bacteriological exhibit an effort was made to show the methods of bacteriological work, and how milk, butter, and cheese are affected by the presence or absence of different kinds of bacteria. The laboratory was equipped with the ordinary apparatus for investigations on nonpathogenic germs, including a dust-proof culture room, culture ovens, vats for cream-ripening, sterilizing apparatus of various kinds, microscopes, etc. During the Fair experiments were conducted in making culture fluids, separating and purifying species, preparing pure cultures, etc. Cultures of the different species of bacteria found in milk and its products were exhibited. With the aid of a small churn butter was made from time to time into which were introduced various kinds of bacteria, some of which had a favorable effect on the flavor of the butter, while others rendered it unpalatable. This exhibit was prepared by Prof. H. W. Conn, of Wesleyan University, as a part of his work for the Connecticut Storrs Station.

The oyster-culture exhibit, prepared by Prof. Julius Nelson, of the New Jersey Station, illustrated different methods for the propagation of oysters.

Collective College and Station Exhibits.

The collective experiment station exhibit included nine alcoves. The material for each alcove was collected by some station officer. The alcoves and their respective chiefs were as follows: Animal nutrition, W. H. Jordan, of Maine; dairying, H. H. Wing, of New York; feeding stuffs, W. A. Henry, of Wisconsin; soils, E. W. Hilgard, of California; fertilizers, M. A. Scovell, of Kentucky; crops, C. S. Plumb, of Indiana; horticulture, E. A. Popenoe, of Kansas; botany, S. M. Tracy, of Mississippi; and entomology, H. Osborn, of Iowa.

The alcove for animal nutrition contained graphic illustrations of the composition of rations, the effect of food on the production of fat and lean meat, the digestive tracts of a number of domestic animals, and an oyster exhibit.

The dairy alcove contained apparatus for the various rapid methods for the estimation of fat in milk, devised by station workers, and a series of bottles graphically illustrating the composition of milk, the efficiency of methods of creaming, and the effect of food on milk production.

A large number of the more common commercial feeding stuffs, a collection of grasses and forage plants, graphic illustrations of the amount of food nutrients

and water in a given amount and number of feeding stuffs, and a round silo for preserving green crops, were shown in the feeding-stuffs alcove.

The soil alcove contained an exhibit of soils from nearly every State in the Union. Here also were exhibits showing the root development of corn, oats, clover, etc., and the amount of water taken up by various crops during their growth.

In the fertilizer alcove were shown collections of various kinds of fertilizing materials and the effects of different fertilizers on corn, cotton, wheat, etc.

The crop alcove contained a large collection of field crops, an exhibit showing the effect of culture on cotton fiber, and another showing the effect of climate on a number of varieties of corn.

In the horticultural alcove were a large exhibit showing the effect of cross fertilization of peas, a collection of citrus fruits, photographs showing the construction of greenhouses, etc.

The botanical alcove showed common weeds and a large number of plant diseases and their distribution.

Collections of economic entomological specimens, insecticides, spraying apparatus, etc., were shown in the entomological alcove.

The collective college exhibit illustrated methods of teaching agriculture and mechanic arts at the land-grant colleges throughout the country, and contained illustrations of student work. This exhibit included an alcove of domestic economy, provided for by Mrs. N. S. Kedzie, of Kansas, and a veterinary alcove, the material for which was collected by Dr. E. A. A. Grange, of Michigan.

A detailed report of the college and station exhibits will be made in the report of the Board of Management to the President.

This coöperative exhibit in its entirety was a model in its scope, completeness, and perfection. It was in its way a gem—*multum in parvo*.

EXHIBIT OF THE DIVISION OF MICROSCOPY.

The exhibit of this division consisted of three sections.

Section 1—Instruments.

The first included instruments of precision used in microscopical investigations. In this group the following were the most noticeable:

(1) A finely made instrument designed principally for testing the value of farmers' binding twine. This instrument not only shows how much strain the twine will bear in pounds weight, but also the amount of its stretch before breakage, in inches and fractions of an inch.

(2) An instrument of a similar character, which shows the relative tensile strength and stretch of individual fibers in the examination of cotton, wool, hair, ramie, flax, etc.

(3) An instrument of great value used in determining the respective diameters of fibers. With this instrument the one-fifty-thousandth of an inch may be measured with greater accuracy and in less time than a merchant could measure a yard of cloth. In the construction of this instrument a single thread of a spider's web plays an important part.

(4) An instrument known as the "Oleomargariscope," which is used in differentiating oleomargarine from butter.

(5) A recently improved spectroscope, a form of microscope sometimes employed to determine the character of blood, whether venous or arterial; also valuable in the differentiation of metals in a state of combustion.

(6) A new and improved freezing microtome, by means of which, with a freezing mixture of salt and water, animal or vegetable tissue may be cut into sections so thin as to become transparent and thus adapted for examination under high powers of the microscope.

Section 2.—Crystallization of animal and vegetable fats.

The second section of the exhibit consisted of a series of enlarged microphotographs, showing the crystallizations of different vegetable and animal fats, as viewed under the microscope, with polarized light and selenite. These diverse forms of the fat when crystallized under certain conditions enable the detection of the fraudulent compounds offered for sale under the name of butter and also of lard.

Section 3.—The economic value of mushrooms.

The third section of the exhibit was designed to show the economic value of mushrooms as an esculent. The edible and poisonous mushrooms of the United States were represented by means of models and, where practicable, by the natural specimens, the edible species largely predominating. A considerable portion, and by far the largest, of the space allotted to the division was occupied by this neglected branch of food products. Such field collections were made in advance as were practicable to supply models. The collections made in the summer and autumn of 1891 were chiefly by the chief of the division and assistants, in Maryland and Virginia, within a radius of 30 miles of the District of Columbia. The agricultural experiment stations assisted in collecting specimens, as also some private individuals, but the complaint was general that the season of 1892 was unfavorable to mushrooms and hence for collecting. Notwithstanding this and other difficulties, types of most of the prominent genera and species of the edible and poisonous mushrooms were secured and molded directly from the fresh specimens. As each mold was made notes were taken of color, manner of growth of each, as whether cæspitose or solitary, and other data necessary for identification; sketches in water-colors were also made when convenient. The models were made of a new, light, flexible material, which admirably serves the purpose, preserving the external physical characteristics of the specimen; thus formed and colored to nature, the models serve as good standards for comparison.

This section of the exhibit represented a forest scene. The various forms of edible mushrooms commonly found on forest trees, together with many varieties of the coriaceous or woody and parasitic kinds, were shown as if growing on tree stumps, faithful imitations of those of the forest. In the foreground appeared mushrooms as if growing in their native earth or embedded in moss. These included not only the edible and poisonous kinds, but also others which, although possessing no special value as food products, cannot be classed as deleterious. The exhibit of the coriaceous fungi consisted of the plants themselves, as collected in the forest. In selecting specimens for the exhibit it was made a point to choose not only those most useful for food, but also the most pernicious kinds, particularly those liable to be confounded with the edible varieties by an unpracticed eye. The common meadow and the larger horse mushroom were well represented. All stages of growth were illustrated in the groups, each group showing the various forms and colors of a species from youth to maturity—from the embryo to old age. The microscope is indispensable in all researches pertaining to fungology and in investigations of the edible and poisonous mushrooms. The very minute microscopic bodies called spores, to the dissemination of which these plants owe their reproduction, and according to the colors and forms of which the numerous subdivisions of this branch of botany are classified and named and become familiar under their common synonyms, can only be seen with the aid of the microscope with powers varying, as the case may be, from 300 to 500 diameters.

The exhibit included altogether about 1,000 models.

EXHIBIT OF THE OFFICE OF FIBER INVESTIGATIONS.

In the exhibit of the Office of Fiber Investigations were shown 530 specimens of fibers and their partial manufactures, scientifically arranged. The object sought was

to present in one collection, in the different stages of preparation, all the fibrous plants growing, or that may be cultivated in the United States, as well as the fibers imported into this country for actual manufacture. These were shown in series from the straw, stalk, leaf, or other crude form, through the most common stages of preparation, to some simple form of manufacture. This scheme was carried out very completely.

The individual specimens were exhibited in their full length, in quantity, in boxes 5 feet long (or divisions of this length) 6 to 18 inches wide, of varying depths, the fibers relieved by pale blue background, and each specimen marked with a printed label giving all necessary data concerning it. The boxes were finally grouped in upright cases, 10 to 15 feet long, and 8 feet high, under plate glass, admitting of the greatest convenience of examination short of actual handling.

The flax collection filled three cases. Samples of straw, representing the Department's flax experiments of 1891 and 1892, were shown from nearly every flax-growing State in the Union, and these specimens were followed by samples of the fiber of American growth and preparation. American linen manufacture was represented by some beautiful examples especially manufactured for the Department by the Stevens Linen Mills, of Webster, Mass., and the Sioux Falls Mills, South Dakota. A panel 5 feet square illustrated the "homespun" linen manufacture of our grandfathers' days. Then followed the imported flaxes, which are used in American manufacture, and a few leading manufactures. This idea of the scheme of exhibition was followed in illustrating each industry. Other fibers and their partial manufactures exhibited were as follows:

Hemp shown from the stalk to cordage, from W. J. Loughridge; jute stalks and fiber produced in Louisiana and Texas; imported fiber and manufactures from the Ludlow Manufacturing Company; the ramie series illustrated the growth of this textile in the Gulf States and California, from stalks to filasse, the latter prepared by W. T. Forbes. With the China grass of commerce was shown a beautiful series of American ramie manufactures, the donation of Jones & Warr. A French series was also exhibited. The series of bast fibers was completed with a case devoted to such experimental species as are indigenous to this country—okra, cotton stalk, Abutilon, Asclepias, Sesbania, etc.

The second division embraced the leaf fibers as follows: Sisal hemp from the Department's experiments in Florida, with a leaf model; false Sisal hemp from Florida; Bahamian and Yucatan imported fiber; cordage manufactured by Travers Brothers; pineapple fiber, bowstring hemp, Yucca fiber, California and imported New Zealand flax, with leaves; manila hemp and cordage, Travers Brothers; ixtle plant, fiber, and brushes, manufactured and donated by Wm. Wilkins & Co.; native banana fiber; two collections, in series, illustrating the saw, and cabbage palmetto industries, with brushes, upholstery, and plastering fibers, from the Palmetto Fiber Company and the Loomis Manufacturing Company; the cocoanut-fiber industry in series, with section of a nut showing source of the fiber; husks from Florida, and imported cocoanut fiber and manufactures from Darrah and Smail; pine-needle bagging and upholstery fiber, with matting and bagging, from Acme Manufacturing Company; Spanish moss, raw and prepared, from The Great Southern Fiber Company; canebrake and fiber extracted from the cane, Phillips Fiber Company, etc.

A series of bromide enlargements, size 22 by 27 inches, from photographs of fiber plants, machinery etc., formed a frieze about the entire exhibit, the blank walls being decorated with two colors of American linen in panels. Photographs were also distributed through the fiber cases as far as possible showing manner of growth of the plants.

EXHIBIT OF THE DIVISION OF ILLUSTRATIONS.

The object of the exhibit of the Division of Illustrations was to show not only the work of the division in illustrating the scientific publications of the Depart-

ment, but also to exhibit the different methods of reproducing these illustrations as they appear in the publications. The exhibit embraced the following:

(1) Original drawings of various biological objects, made either in pen and ink, lead pencil, crayon, ink-wash, or water-color painting. In the enlarged and framed pictures the same objects were exhibited, also fruits and flowers, to show the style and especial care of treating this class of illustrations for reproduction.

(2) Wood-engravers' proofs which represented engravings of entomological and botanical subjects.

(3) The different methods of reproduction used by the Department in its publications, which were as follows: (*a*) Wood-engraving, showing the process from the rough boxwood, the manner of preparing it for the engraver's use, the different ways of putting the subject on the wood, the engraver's tools, engraved plate proofs and electrotype; the complete process from beginning to end. (*b*) Photo-engraving and half-tone process—the original drawing, negative plate, etched plate, and final proof. (*c*) Chromolithography, showing original painting, process of putting the drawing on the stone, and the 10 stone proofs, exhibiting the gradual development of printing in colors.

Exhibits of Other Divisions.

Silk exhibits.—Although the work of the Silk Division of the Department was closed by Congress about the same time active operations were commenced in connection with the Department exhibit, still a showing of that branch was made. It consisted of a tastefully arranged case on the main aisle, showing the different races of cocoons, both foreign and domestic, reeled and raw silks, manufactured products, and in three large frames were displayed enlarged models of the silkworm.

Statistics.—Of necessity the exhibit made by the Division of Statistics took the form of colored maps and charts, 10 in number, showing, respectively, (1) the export of hog products; (2) average wages of farm labor; (3) wheat values and yield per acre; (4) varying effect of product on price of corn; (5) map showing acquisition of territory in the United States; (6) progress of cereal production in the United States, from 1849 to 1891; (7) cereal products of the world from official and other records; (8) acreage in corn per thousand acres of superficial area; (9) acreage in wheat per thousand acres superficial area; (10) corn (maize) values and yields per acre in average of ten years.

Records and Editing.—The exhibit of the Division of Records and Editing consisted of a complete set, so far as obtainable, of all the reports, bulletins, and other publications of the Department from its origin up to that time. These were shown for the most part in connection with the different divisions issuing the same. A large number of the Department publications were distributed freely and were evidently appreciated.

REPORTS

OF THE

CHIEFS OF BUREAUS AND DIVISIONS

OF THE

U. S. DEPARTMENT OF AGRICULTURE

FOR

THE YEAR 1893.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

SIR: I have the honor to transmit herewith a report on the work of the Weather Bureau during the year 1893.

Very respectfully,

MARK W. HARRINGTON,
Chief.

HON. J. STERLING MORTON,
Secretary.

WORK OF THE YEAR.

During the current year the work of the Bureau has been carried on successfully and the expenditures kept well within the appropriations. The reduction in total cost of maintenance is about 10 per cent, and the estimates for the present fiscal year have been correspondingly reduced, with the confident expectation that, while more economically administered, the service will lose nothing of its value to the public nor have its efficiency impaired.

REORGANIZATION OF BUREAU FORCE—RESULTS.

A general reorganization of the Bureau, however, has been effected, with the satisfactory result of eliminating discordant elements, systematizing the work, and establishing harmonious and concerted efforts to increase the value of the service to the public. This readjustment added largely to the labors and responsibilities of certain divisions without corresponding increase of working force. In order to afford all proper guaranty of success and honesty in the disbursement of funds and care of property, important changes were made in the purchasing and disbursing divisions, the general effect of which is to have all matters relating to property and funds receive the indorsement of two independent officers.

In January, 1893, the entire force of local forecast officials and observers was brought within the classified service by Presidential order, and since that date all appointments to such force have been made through the Civil Service Commission. While 19 persons have been separated from the classified station force during the period covered by this report, but three requests have been made for certifications during the same period. This, of course, has somewhat embarrassed the service in its general station work; yet in furtherance of the policy of the Bureau to reduce the station force to the smallest possible number consistent with efficiency, every effort has been made, by a judicious placing of the present force, to maintain the high standard of station work.

The purely executive work of the Bureau, heretofore occupying the attention of a separate and distinct division of the office, has been added to the duties of the chief clerk; other work not considered executive has been subdivided and variously assigned to the proper branches of the office. This change has not only resulted in the discontinuance of the "executive division," but has also permitted a more satisfactory conduct of the business of the office.

DIVISIONAL DUTIES AT THE CENTRAL OFFICE.

The work of the central office is at present subdivided as follows:

Chief Clerk's Office.—Under the immediate supervision of the chief clerk. Herein are performed the usual duties of the chief clerk as prescribed by the statutes, and all work pertaining to the general management of stations, general correspondence, the supervision of printing and publications, and the direction of the captain of the watch and the force on duty under him.

Forecast Division.—Under the immediate supervision of the assistant chief of Bureau. Twice a day the reports received in cipher are charted on the daily weather map. This division has charge of all forecasting, exercising general supervision over the work of all local forecasters. Subdivisions of this division are river and floods section, the telegraph room, storm signal stations, and lake marine service.

Records Division.—Under the charge of a clerk of class 4. Examines and checks all meteorological forms, computes normals for use in the forecast division, and prepares the data used in the Monthly Weather Review.

Accounts Division.—In charge of a clerk of class 3, acting as assistant disbursing officer. Has in charge the disbursement of all funds appropriated for the Bureau.

Supply Division.—Is charged with the purchase of all supplies necessary for the work of the Bureau, the supervision of contracts and the issue and transportation of supplies, and the checking of property returns showing the accountability of observers for public property.

State Weather Service Division.—Has sole charge of all matters pertaining to the selection and equipment of voluntary stations and the distribution of temperature and weather signals.

Publications Division.—Is, as its name implies, concerned with the publication, issue, and distribution of all weather maps, special circulars, reviews, bulletins, and miscellaneous printed matter.

Instrument Section.—Attends to the standardizing and maintenance of the instrumental equipment of stations.

The Library.—Consists of nearly 15,000 books and nearly 5,000 pamphlets. The bibliography of meteorology comprises more than 65,000 titles.

The Monthly Weather Review.—Contains tabulated statements of meteorological conditions for the period of one month, and also serves as a means of acknowledgment of the reports of some 2,500 voluntary observers in the United States, a copy of the Review being furnished each observer.

In all, 183 persons, when the rolls are full, are employed in the Bureau at Washington. Three of this number (the inspectors) are, however, employed the greater portion of their time away from Washington. To perform the scientific and clerical duties, 107 persons are necessary; 92 of these are in the classified service.

FORECAST OFFICIALS AND OBSERVERS.

At the present date the regular (classified) observing force of the Bureau consists of 30 local forecast officials, at $1,500 each per annum, and 269 observers, at salaries ranging from $600 to $1,400 per annum. In addition to this force there are employed 4 persons (telegraph operators, etc.) who are not regular observers, but whose duties involve one or more observations daily.

The number of local forecast officials is limited by law, and the present number is far below that needed. The value of these officials to the local interests of the communities in which they are serving is well known and highly appreciated, as shown by the increasing demand for such services.

In addition to the force of local forecast officials and observers a number of stations are employing messengers and special (temporary) assistance. In many cases these employees, whose monthly compensation averages about $25, are hired for a portion of the year only—that is, for the busier season of the year. It is intended to gradually lessen the number of persons thus employed; and to this end the services of 28 have been discontinued during the present year, while a further reduction is contemplated.

It is gratifying to state that within the past year there has been a very thorough readjustment and equalization of salaries of the general observing force. The transfer of these men from the Department of War to the Department of Agriculture brought with it a complicated and unclassified pay account, incident to the military rank, station, and other conditions governing this force while it was serving as an enlisted corps. The introduction of a classification more in harmony with that of a civil branch of the public service, with a limited appropriation, was a difficult task to accomplish; but the classification, as finally agreed upon and now in operation, is, in the main, quite satisfactory and involves but 9 grades of pay, as against 42 under the old system.

Experience has demonstrated that military management and discipline are not essential to an efficient weather service, and it is gratifying to report that the present civilian management has found no difficulty in maintaining the necessary stations at the most isolated points. The employees of the Weather Bureau, with very few exceptions, have performed their duties with absolute promptness and fidelity, and to the faithful and intelligent execution of the arduous labors of the observing force must, in the largest measure, be ascribed the high standard of efficiency which has been attained by the national weather service.

OBSERVING STATIONS.

There are at present in operation 156 regular (paid) stations of the Bureau. During the current year 3 new stations were established at a moderate cost, while 14 were discontinued as useless for the purposes of the Bureau, thus effecting a material reduction in the general expenses of the service.

Of the 156 stations now in operation, 60 are located in rooms furnished free of cost to the Bureau for occupancy (47 in Government buildings and 13 in buildings owned by corporations or individuals), while 96 are located in quarters for which rent is paid from the funds of the Bureau.

The importance of the regular inspection of the observing stations of

the service can not be overestimated. These inspections involve a close scrutiny and report upon the general work of the stations of the Bureau; an examination into the exposure of the meteorological instruments; the preparation and dissemination of forecasts, maps, bulletins, etc.; the care and safety of public property; the conduct and value of services rendered by the personnel of the observing force, etc.

Seventy stations have been inspected during the present calendar year.

The meteorological work pertaining to the Pacific coast has continued to receive the attention due to this important section. Every effort has been made to increase the usefulness of the service there. It is hoped at some date in the future to have an official of high rank stationed in San Francisco in addition to the local forecast official.

This service continues to send daily cablegrams to the French meteorological bureau at Paris, containing marine data obtained from the logs of incoming vessels, the position of areas of highest and lowest pressure in the United States, and data from two selected stations in the Canadian maritime provinces.

BUREAU EXHIBIT AT WORLD'S FAIR.

The official in charge of the instrument room was assigned as special agent in charge of the Weather Bureau exhibit at the World's Columbian Exposition. The exhibit aimed to set forth all the characteristic features of the work of the Bureau. The general climatic conditions of the United States were shown in a series of 42 finely executed normal charts, compiled from the long series of observations in possession of the Bureau.

The complete work of receiving telegraphic weather reports and the preparation of daily forecasts of the weather therefrom was fully shown and illustrated by the actual preparation and printing, lithographically, of a morning weather map for distribution among the visitors.

In addition to these features there were exhibited, in continuous and actual operation, each of the instruments used by the Bureau in procuring automatic records of the weather conditions; also many other typical instruments employed by meteorologists in general.

During the time the exhibit was open to the public, experienced employees of the Bureau were always on duty to give verbal explanation to visitors respecting all the details of weather forecasting, the operation of instruments, and all other points connected with the work of the Bureau. By this personal attention to those interested it was possible to impart to a very large number of people correct ideas of the real work being done by the Bureau, and this information excited the highest appreciation on the part of visitors, many of whom expressed themselves to that effect in the most emphatic way.

INTERNATIONAL METEOROLOGICAL CONGRESSES.

The Official International Congress of Meteorologists, which it was hoped would have been held at Washington in August, had to be abandoned, owing to causes which need not be given in detail here. As a substitute therefor a congress of meteorologists was held at Chicago August 21 to 24. Many papers of great importance were presented from the leading meteorologists of the world, making a valuable contribution to the science of meteorology. The Bureau has undertaken to publish these memoirs, and copies will be duly distributed to authors and public libraries.

At the International Meteorological Congress held at Munich, August, 1891, an international meteorological committee was appointed, with a representative from each of the leading meteorological services of the world. The Chief of the Weather Bureau is one of the members of this committee. It is the prime object and purpose of this committee to make the work of the different meteorological services as uniform as practicable and to promote coöperation among the various services on all important questions. A communication from the chairman of this committee, Dr. H. Wild, of St. Petersburg, recently received, proposes a meeting of the committee at some central point in the summer of 1894. At this meeting will, in all probability, be discussed the general subject of agricultural meteorology, in accordance with the propositions of Messrs. Wild and Harrington at the Munich conference; also the matter of a more complete and uniform method of observing clouds.

SEASONAL FORECASTS.

The subject of seasonal forecasts has not heretofore been considered profitable for discussion, but an attempt which has been made within the past two or three years by the meteorological service of India in this direction indicates a path by which useful results can perhaps be reached. This matter is receiving the careful attention of the Bureau, and when it is believed that predictions of this sort can be made of value, the attention of the scientific force will be directed to the subject with the hope of improving the forecasts.

Prof. Bigelow continues his studies of magnetism with sufficient prospect of success to justify the time and labor expended.

DEATHS BY WIND AND LIGHTNING.

Statistics showing deaths by high wind and lightning have been prepared as in former years. The loss of life by wind storms has been very great as compared with other years, the number of deaths from that cause during the last four years being as follows: 273 in 1890, 108 in 1891, 190 in 1892, and 399 in 1893. The loss in March and April of the past year was especially great—96 and 174, respectively, or more than 67 per cent of the whole.

ADVISABILITY OF EXTENDING THE FIELD OF OBSERVATION.

In the Monthly Weather Review opportunity has been taken to explain how the movements of the atmosphere, with its storms, cold waves, frost, etc., illustrate the mechanical processes involved. This review contains a running series of notes and explanations intended to throw such light upon atmospheric phenomena as must eventually improve our methods of weather prediction. The conclusion, long since derived from other sources, that the area covered by our daily map is too small to allow of sufficiently comprehensive studies, is now again confirmed, and every means should be taken to extend the map so as to cover Mexico, the West Indies, and Central America on the south, and to extend as far north as possible into Alaska and the Aleutian Islands and west to the Hawaiian Islands.

YEARLY VOLUME OF METEOROLOGICAL DATA.

A very important work of the year, so far as the results affect the general public, was the preparation of the manuscript for the yearly volume

of meteorological data, authorized by the concurrent resolution of Congress, dated February 19, 1893. The volume, consisting of 528 quarto pages, has since been printed, but has not yet been received from the binder. It contains the results of meteorological observations during 1891 and 1892 from upwards of 2,000 stations, and has already proved of importance and value in the work of the office as well as to students and others seeking information as to the climatic conditions which obtain in the various sections of the country.

RECOMMENDATIONS.

Attention is invited to the necessity of a closer coöperation with the weather services of Mexico and the Bahamas. The need of full telegraphic reports from the latter was clearly shown very recently. The disastrous hurricane of August 28 emphasized unfortunately but too well the value of telegraphic communication with the stations in the West Indies.

In connection with the storm of October 2–5, 1893, there arose in the public press some comment as to the inability of this Bureau to give warning to communities on the Gulf coast. A year ago, when in Mexico, the chief made arrangements with the director of the Central Meteorological Observatory to have an international exchange of telegrams on terms similar to those in operation between the United States and Canada; the Mexican service to deliver without expense to our agent at the nearest point certain data and receive a return in kind. Negotiations have, therefore, been resumed looking to a full and free interchange of meteorological information.

The suggestion is also made that a more efficient and satisfactory distribution of railway forecasts could be made if the postal clerks on mail trains were intrusted with the display of signals and made responsible therefor. This would require very little time on the part of the clerks, and the expense to the Bureau would be reduced to a minimum.

Uniformity in publication and distribution of the reports of the State weather services is also a matter to which attention is respectfully invited. It is much to be desired that the various bulletins be uniform in appearance, and that each State should appropriate a sufficient amount to cover the cost of publication. The observer should not be compelled, as now, in some cases, to print as a private enterprise. It is possible that some plan of coöperation between this Bureau and the States in the matter of printing the reports might be adopted to secure general and uniform publication.

Attention is invited to the existing civil service regulation which permits the transfer of clerks from one Department of the Government to another. When such a transfer is made solely with reference to the work to be performed, it may be advantageous to the public interests; but such is not usually the case, and it is generally a disadvantage. By the operation of this rule it is possible for an employee of any Department to secure transfer to another branch of the departmental service, provided he may secure the consent of the head of the Department to which such transfer is to be made. Almost invariably, it is believed, such consent is obtained whenever sought, and frequently through the personal efforts of the influential friends of the employee. The result is that an employee whose services for years have been devoted to a particular class of work in a certain Department or Bureau (and whose value to that Department or Bureau is relatively great) secures a "transfer," leaving a branch wherein he is experienced and

valuable to assume untried duties in a Department or Bureau whose appropriations permit it to offer him advantages in a pecuniary sense. If the employee is worth more money he ought to be able to secure it, if anywhere, in the Bureau where he can render the most valuable service; and where his superiors can not so reward him, it is due to the inelastic system which now prevails, and which is so discouraging to legitimate ambition and individual effort.

In view of the present faulty and unsatisfactory system of filing the correspondence of the office, plans for an improvement therein have received due consideration, and in another paper suggestions have been made for simplifying this work. At present there are five or six different files of letters, and it is proposed to reduce this number to at most two files.

The present locations of inspectors (Nashville, Boston, and Detroit) not only render the movements of these officials expensive, but necessitate delays in inspection of stations at distant points. Therefore it has been suggested to the Secretary of Agriculture, with a view to economy, that the country should be divided into three inspection districts: (1) The lakes, New England, and Middle Atlantic States; (2) including the central valley to the Rocky Mountains; and (3) to include stations west of the Rocky Mountains; placing an inspector at a central point in each of the three districts.

FORECASTS.

THE DAILY WEATHER MAP.

The daily weather map is now issued at 72 stations of the Weather Bureau outside of Washington, D. C., the issue on November 1, 1893, being 8,867 copies, or over 2,500,000 copies annually.

These maps, showing the weather conditions of to-day and the probabilities for the morrow, are given the widest possible circulation with the means at hand. As a means of disseminating forecasts and the weather conditions which obtain over a large area of country, the map is much superior to any process yet devised; there is this objection, however, viz, that in its present form it does not reach the masses. The ideal system of distributing the information collected by the Bureau is one which would place the daily weather map in the hands of the reading public at an early hour, through the daily press or other medium. It is believed that present efforts should be directed towards the reproduction of a legible map in the daily papers, which shall contain the forecasts and such other climatological data as may be of importance to the community in which the paper is printed. Efforts in this direction have been made heretofore and with great success for a limited period, but in some cases the ground thus gained has been lost through causes beyond the control of the Bureau. Rivalry has not only aided in the publication of maps in the daily papers, but in many cases it has been the cause of discontinuing them. Recent efforts to secure the publication of the maps in large dailies under a contract seem to warrant the belief that if the publication can be made exclusive it can be done for a nominal sum. The importance of the subject warrants careful consideration.

There has been but little change in the number of stations issuing maps and bulletins since last report, but it has been possible to secure the material and supplies now used in such work at greatly reduced prices as compared with those of last year, thus enabling the Bureau

to maintain its large daily issue with less expenditure of money than ever before.

Minor improvements in the mechanical details of map-making are being constantly suggested to the officials charged with this important duty.

OFFICIAL RATINGS.

While official ratings continue to be taken and are found to be guides to the chief of the forecast division and the prosecution of the work, and while the present ratings are in nowise inferior to previous ratings, yet it has become so clearly evident that these percentages are not true exponents in every respect of the success of the forecasts, and as they unquestionably limit the freedom of the forecaster in his arduous and hurried work, the policy of the office this year has been to encourage the forecasters to make their forecasts with more freedom, keeping less in mind their ratings than the satisfaction of the public. This, it is believed, has had a useful effect, in that it has rendered the forecasts more intelligible to the public, leaving the forecaster, as it necessarily does, more free to express his own estimate of the approaching weather conditions. The official ratings for 1893 are given in Tables I, II, III, IV, and V, which follow:

TABLE I.—*Percentages of verifications of 8 p. m. 24-hour forecasts for the year ending December 31, 1893.*

States.	January.			February.			March.			April.		
	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.
Maine	92.3	71.9	84.1	89.6	94.3	91.5	78.4	95.5	85.2	86	77.3	82.5
New Hampshire	86.1	76.5	82.3	91.1	90.4	90.8	86.5	93.9	89.5	89	84.7	87.3
Vermont	83.5	74.2	79.8	94.6	82.5	89.8	90	91.9	90.8	91	86	89
Massachusetts	85.5	84.5	85.1	92.9	92.9	92.9	85.2	83.9	84.7	83.3	90.3	86.1
Rhode Island	80	85.5	82.2	92.9	87.5	90.7	84.5	87.1	85.5	83	92.3	86.7
Connecticut	83.2	88.7	85.4	92.9	94.6	93.6	84.5	86.5	85.3	78.7	87	82
Eastern New York	90.3	87.4	89.1	89.6	96.4	92.3	89	77.7	84.5	88	81	85.2
Western New York	83.2	95.5	88.1	92.5	91.1	91.9	91	79	86.2	82.3	80	81.4
Eastern Pennsylvania	84.8	95.2	89	88.6	88.6	88.6	94.8	75.8	87.2	87.3	69.7	80.3
Western Pennsylvania	73.5	95.2	82.2	86.4	86.8	86.6	91.6	82.6	88	77.7	89.7	78.9
New Jersey	87.4	96.1	90.9	87.9	91.1	89.2	93.9	82.3	89.3	89.7	82	86.6
Delaware	84.2	94.2	88.2	86.8	92.9	89.2	97.1	86.5	92.9	80	72.7	77.1
Maryland	79.4	89.7	83.5	84.3	93.9	88.1	87.1	82.9	85.4	78.3	70.7	75.3
District of Columbia	81.6	78.4	80.3	86.8	90.4	88.2	90.3	83.9	87.7	80	66.7	74.7
Virginia	80.3	86.5	82.3	82.1	88.6	84.7	88.1	77.7	83.9	83.7	75	80.2
North Carolina	84.5	76.8	81.4	83.2	84.3	83.6	84.5	87.7	85.8	82.3	76.3	79.9
South Carolina	92.9	73.9	85.3	80.7	73.6	77.9	83.9	89.7	88.2	86.7	80.7	84.3
Georgia	95.8	76.1	87.9	80.4	78.9	79.8	87.4	92.6	89.5	82	88.3	84.5
Eastern Florida	88.4	80.6	85.3	87.9	88.2	89	89.4	90.3	89.8	80.3	93.7	85.7
Western Florida	99.4	82.6	92.7	71.4	82.1	75.7	88.7	91	88.6	86	96.7	90.3
Alabama	92.9	86.5	90.3	78.6	65	73.2	81	91	85	85.3	90.7	87.5
Mississippi	87.1	86.5	86.9	73.2	80.7	76.2	75.2	89	80.7	90	89.3	89.7
Louisiana	82.9	86.8	84.5	73.6	76.4	74.7	84.5	83.2	83	85.3	90.7	87.5
Texas	83.2	77.7	81	80	87.9	83.2	89.7	89.7	89.7	87.3	83.7	85.8
Arkansas	81.3	66.8	75.5	80.7	87.1	83.3	82.3	81	81	87.7	86.7	87.0
Tennessee	90.3	72.9	83.3	82.5	85.7	83.8	90	84.8	87.9	79	78.7	78.9
Kentucky	75.8	74.5	75.3	84.6	91.1	87.2	91.6	82.6	88	86.3	85.7	86.1
Ohio	79.7	82.3	80.7	88.2	82.9	87.1	88.4	75.8	82.4	78.3	75.3	76.1
West Virginia	67.7	87.1	75.5	82.9	92.9	86.9	85.5	81.3	83.8	75.7	84.3	80.1
Indiana	77.1	76.8	77	88.6	84.3	85.9	92.9	83.5	89.1	83.3	81	82.4
Illinois	77.1	77.7	77.3	91.4	86.1	89.3	90.3	85.5	88.4	78.7	82	80
Lower Michigan	80.3	65.8	74.5	85.7	90.4	87.7	87.1	87.1	87.1	84	93.3	87.7
Upper Michigan	78.1	81	79.3	78.2	76.8	77.6	73.2	89	79.5	82.7	91	86
Wisconsin	77.1	75.2	76.3	89.6	72.9	82.9	90	91.9	90.8	75.3	77	76
Minnesota	79	75.5	77.6	83.9	81.8	83.1	85.2	88.1	86.4	67	78.7	71.7
Iowa	79	86.5	82	91.4	80.7	87.1	87.4	86.8	87.2	79.7	82	80.6
Kansas	90.6	65.5	80.4	86.4	82.1	84.7	79.4	70.3	75.8	85.3	69.3	78.9

TABLE I.—*Percentages of verifications of 8 p. m. 24-hour forecasts for the year ending December 31, 1893*—Continued.

States.	January.			February.			March.			April.		
	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.
Nebraska	89·7	81·3	86·3	95·7	82·1	90·3	84·2	70·6	78·8	88·3	78·3	84·3
Missouri	80·6	80·3	80·5	92·1	83·6	88·7	80·3	81·3	80·7	78·7	76	77·6
Colorado	88·7	64·8	79·1	84·6	84·6	84·6	83·5	73·5	79·5	90·3	86·7	88·8
North Dakota	82·9	75·5	79·9	77·9	86·4	81·3	78·7	77·1	78·2	80	89	83·6
South Dakota	84·2	82·9	83·7	97·5	81·4	91·1	82·6	71·9	78·3	78	85	80·8
Average	83·8	80·8	82·7	86	85·5	85·8	86·4	84·1	85·5	82·9	82·5	82·7

States.	May.			June.			July.			August.		
	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.
Maine	84·8	78·7	82·4	74	61·3	68·9	81·3	71	77·2	88·7	65·8	79·5
New Hampshire	87·1	84·2	85·9	74·7	80	76·8	74·2	71	72·9	86·5	65·5	78·1
Vermont	83·9	88·7	85·8	77·7	79	78·2	67·7	75·8	70·9	81·8	66·1	77·3
Massachusetts	91	83·9	88·2	87	75	82·2	68·1	75·8	71·2	87·4	62·9	77·6
Rhode Island	87·1	84·5	86·1	77·7	75	76·6	81·9	77·7	80·2	89·7	71	82·2
Connecticut	86·1	82·6	84·7	87·3	74·7	82·3	80·3	76·5	78·8	88·7	64·8	79·1
Eastern New York	89·7	93·9	91·4	85·7	82·3	84·3	82·9	75·2	79·8	81·9	67·1	76
Western New York	84·5	80·3	82·8	87·7	79·3	84·3	86·1	74·5	81·5	82·3	79	81
Eastern Pennsylvania	90·6	93·5	91·8	91·3	84·7	88·7	81·3	78·4	80·1	73·2	60·6	68·2
Western Pennsylvania	78·4	82·6	80·1	88·7	75·7	83·5	73·5	68·4	71·5	73·9	79·7	76·2
New Jersey	93·9	88·7	91·8	95	79·3	88·7	85·2	83·2	84·4	64·2	62·9	63·7
Delaware	93·5	95·2	94·2	93·3	85	90	84·8	87·1	85·7	68·7	67·7	68·3
Maryland	93·9	92·3	93·3	92·7	81·3	88·1	81	80·3	80·7	69·4	63·5	67
District of Columbia	85·5	88·7	86·8	88·7	80	85·2	81	74·2	78·3	67·7	59·7	64·5
Virginia	85·8	89	87·1	86	80·3	83·7	86·5	81·9	84·7	75·2	64·5	68·9
North Carolina	92·9	85·8	90·1	78·3	88	82·2	90	76·5	84·6	67·4	60	64·4
South Carolina	81·9	85·5	83·3	78·7	90·3	83·3	81·3	80	80·8	68·7	66·5	67·8
Georgia	81	82·9	81·8	81·3	84·3	82·5	82·6	79·4	81·3	80	70	76
Eastern Florida	84·5	93·9	88·3	90	98	93·2	76·8	95·2	84·2	76·1	78·1	76·9
Western Florida	79	93·5	84·8	76·7	93·3	83·3	71·6	92·3	79·9	59·4	80	67·6
Alabama	86·5	85·5	86·1	79·7	84	81·4	82·3	84·8	83·3	68·1	68·4	68·2
Mississippi	85·2	84·8	85	79	87·3	82·3	81	79	80·2	69	71·9	70. 2
Louisiana	88·4	83·5	86·4	83·7	88	85·4	85·2	86·8	85·8	65·2	70·3	67·2
Texas	90·6	83·2	87·6	88·3	90·3	89·1	86·1	85·8	86	56·5	68. 4	61·3
Arkansas	87·7	68·7	80·1	76	83·3	78·9	82·6	83·2	82·8	68·4	70·6	69·3
Tennessee	77·7	83·9	80·2	77·7	80	78·6	88·7	88·4	88·6	68·4	72·3	70
Kentucky	85·2	85·5	85·3	83·3	79·7	81·9	83·2	82·9	83·1	71·9	71·6	71·8
Ohio	80·6	76·1	78·8	88·7	82·3	86·1	83·9	77·7	81·4	72·9	75·2	73·8
West Virginia	72·9	82·3	76·7	79·3	75·7	77·9	79·4	81	80	67·7	63·5	66
Indiana	87·1	83·5	85·7	85·7	80·7	83·7	83·5	82·6	82·9	83·2	71·6	78·6
Illinois	85·2	80·6	83·4	86·7	82·7	85·1	81·6	81	81·4	86·8	68·1	79·3
Lower Michigan	83·9	89·7	86·2	90·3	86·3	88·7	81·3	78·7	80·3	74·2	85·5	77·7
Upper Michigan	82·6	69	77·2	80	73·7	77·5	82·6	69	77·2	73·2	79·4	75·7
Wisconsin	85·8	72·3	80·4	81·7	84·3	82·7	80·6	79·7	80·2	71·9	70·6	71·4
Minnesota	89·4	73·5	83	69·7	70·3	69·9	82·6	81·3	82·1	72·6	74·5	73·4
Iowa	83·2	78·1	81·2	83·3	72·7	79·1	90	80·6	86·2	63·9	67·7	65·4
Kansas	93·2	75·8	86·2	88·7	73·7	82·7	86·1	81	84·1	70	62·9	67·2
Nebraska	85·8	76·8	82·2	81·3	73·7	78·3	80	77·4	79	65·5	61·6	63·9
Missouri	89·7	81·3	86·3	83	80·3	81·9	91	83·2	87·9	64·2	65·2	64·6
Colorado	87·1	59	75·9	89·7	82	86·6	91·6	73·9	84·5	75·8	50·6	65·7
North Dakota	87·4	74·2	82·1	77·7	82·7	79·7	85·2	70·6	79. 4	77·7	59·7	70·5
South Dakota	85·8	73·5	80·9	82·7	81·7	82·3	79·7	66·5	74·4	77·7	69·4	74·4
Average	86·1	82·6	84·7	83·5	81	82·5	82	79·3	80·9	73·8	68·4	71. 6

TABLE I.—*Percentages of verifications of 8 p. m. 24-hour forecasts for the year ending December 31, 1893*—Continued.

States.	September.			October.			November.			December.			Year.		
	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.
Maine	77.3	84.3	80.1	87.4	78.4	83.8	79.7	86.7	82.5	76.5	87.7	81	83	79.4	81.6
New Hampshire	81.3	79.3	80.5	85.5	72.6	80.3	78.3	90	83	82.6	94.5	87.4	83.6	81.9	82.9
Vermont	78	70.7	75.1	85.8	71.3	80	81.7	83.3	82.3	88.4	94.2	90.7	83.9	80.3	82.5
Massachusetts	82.7	82.3	82.5	95.8	87.7	92.6	77	90	82.2	88.4	89	88.6	85.4	83.2	84.5
Rhode Island	77	87	81	96.8	90.3	94.2	76.3	93.3	83.1	87.1	96.8	91	84.5	85.7	85
Connecticut	78	84	80.4	92.9	91	92.1	74.3	91.7	81.3	85.8	96.8	90.2	84.4	84.9	84.6
Eastern New York	87.3	82	85.2	91.3	78.1	86	84	93.7	87.9	88.1	89.7	88.7	87.3	83.7	85.9
Western New York	80.7	77.7	79.5	80.6	77.4	79.3	96	94	95.2	85.8	86.8	86.2	86	82.9	84.8
Eastern Pennsylvania	82.7	87.3	84.5	93.5	88.1	91.3	79.3	95.7	85.9	90	90.3	90.1	86.4	84	85.5
Western Pennsylvania	80	81	80.4	87.7	84.5	86.4	95.3	90.7	93.5	77.7	83.9	80.2	82	82.6	82.3
New Jersey	78.3	86	81.4	92.6	88.1	90.8	81.3	97.7	87.9	90.3	93.5	91.6	86.6	85.9	86.3
Delaware	84	88.3	85.7	89.7	90.3	89.9	82	91.7	85.9	83.2	88.7	85.4	85.6	86.7	86
Maryland	81.7	94	86.6	87.1	88.4	87.6	84.7	87.3	85.7	84.8	85.8	85.2	83.7	84.2	83.9
District of Columbia	71.7	93.3	80.3	88.7	83.9	86.8	85	80	83	80	80.6	80.2	82.2	80	81.3
Virginia	80.7	93.3	85.7	89	83.2	86.7	86.3	90.3	87.9	81.6	86.1	83.4	83.8	83	83.3
North Carolina	87.7	92.3	89.5	93.5	81.3	88.6	87.7	85	86.6	92.9	93.2	93	85.4	82.3	84.1
South Carolina	90	98.3	93.3	93.5	83.2	89.4	86	80.3	83.7	94.8	94.8	94.8	84.9	83.1	84.3
Georgia	91.3	96	93.2	89.4	79	85.2	86	87.3	86.5	89.7	90.3	89.9	85.6	83.8	84.8
Eastern Florida	84.7	99.3	90.5	78.7	95.8	85.5	76	97	84.4	84.5	89	86.3	83.1	91.6	86.6
Western Florida	89.3	97.7	92.6	100	95.5	98.2	93.3	91	92.4	88.1	96.8	91.6	83.6	91	86.5
Alabama	88	90.7	89.1	90.6	86.5	89	91.7	85	89	87.7	87.4	87.6	84.4	83.8	84.1
Mississippi	91	89.3	90.3	95.5	82.6	90.3	86	85.3	85.7	91.3	85.2	88.9	83.6	84.2	83.9
Louisiana	85.7	90	87.4	91	83.5	88	88.7	82.3	86.1	95.2	85.2	91.2	84.1	83.9	84
Texas	96.7	93.3	94.1	99.4	80.6	91.9	87.7	83	85.8	92.6	85.8	89.9	86.5	83.9	85.4
Arkansas	89	85	87.4	96.8	82.6	91.1	80	80.3	80.1	94.5	86.1	91.1	83.9	80.1	82.4
Tennessee	90.3	92.7	91.3	92.9	80.6	88	85	85.3	85.1	88.7	89	88.8	84.3	82.8	83.7
Kentucky	93.3	95	94	93.5	83.5	89.5	95.7	88.3	92.7	87.4	92.3	89.4	86	84.4	85.4
Ohio	86.7	83	85.2	91.9	82.6	88.2	90.3	87.3	89.1	79	90.3	83.5	84	80	82.7
West Virginia	83.3	84.7	83.9	88.1	74.8	82.8	82.7	91.3	86.1	83.9	80	82.3	79.1	81.6	80.2
Indiana	85	83	84.2	94.2	78.1	87.8	93	87.3	90.7	83.2	86.5	84.5	86.4	81.6	84.4
Illinois	84.3	78.3	81.9	96.5	71.9	86.7	92.3	84.3	89.1	84.2	82.3	83.4	86.2	80	83.8
Lower Michigan	77	72	75	85.2	80.6	83.4	78.3	83	80.2	85.5	94.2	89	82.7	83.9	83.1
Upper Michigan	73.3	78	75.2	76.5	73.5	75.3	86.3	87.7	86.9	81	86.1	83	79	79.8	79.2
Wisconsin	89	83.7	86.9	85.5	72.6	80.3	92.7	95	93.6	86.5	82.3	84.8	83.8	79.8	82.2
Minnesota	92	76	85.6	79.7	73.9	77.4	85.7	83.3	84.7	84.5	74.2	80.4	80.9	77.6	79.6
Iowa	91.7	89.3	90.8	90.3	71.3	82.7	81.7	92	85.8	82.6	73.9	79.1	83.7	80.1	82.3
Kansas	97.7	75.3	88.7	96.1	75.2	87.7	89	85.3	87.5	97.1	74.8	88.2	88.3	74.3	82.7
Nebraska	96.3	74.7	87.7	90.6	75.2	84.4	86.3	84.7	85.7	92.6	82.3	88.5	86.4	76.6	82.5
Missouri	82.7	82.7	82.7	90.6	82.3	87.3	86.7	82	84.8	87.4	79.7	84.3	83.9	79.8	82.3
Colorado	95.3	77	88	92.6	82.6	88.6	74.7	86.7	79.5	94.2	75.8	86.8	87.3	74.8	82.3
North Dakota	87.7	70.7	80.9	84.8	72.3	79.8	83	89.7	85.7	82.6	60.6	73.8	82.1	75.3	79.5
South Dakota	96	73.3	86.9	88.1	74.2	82.5	82.7	85.7	83.9	91.3	77.4	85.7	85.5	76.9	82.1
Average	85.6	85	85.4	90.2	81.2	86.6	85	87.9	86.2	87	86.2	86.7	84.4	82	83.4

PACIFIC COAST DIVISION.

States.	January.			February.			March.			April.		
	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.
North California	92	73.3	84.5	87.1	82.1	85.1	83.2	73.5	78.3	84.7	73	80
South California	94	66	82.8	97.9	77.1	89.6	91.6	67.7	82	97.3	67.3	85.3
Arizona	93.3	63.7	81.5	97.9	86.8	93.5	85.5	79.4	83.1	98.3	87.3	93.9
Nevada	90	65.7	80.3	83.9	72.1	79.2	84.5	66.5	77.3	88.3	65	79
Utah	87.7	76.7	83.3	70	73.2	71.3	86.8	82.9	85.2	78	77.3	77.7
Oregon	85.3	75.7	81.5	73.3	80.4	76.1	74.5	72.9	73.9	83.3	68.7	77.5
Washington	84.3	78.3	81.9	72.6	75.6	73.8	79	80	79.4	82.7	72.7	78.7
Average	89.5	71.3	82.2	83.2	78.2	81.2	83.6	74.7	80	87.5	73	81.7

Table I.—*Percentage of verifications of 8 p. m. 24-hour forecasts for the year ending December 31, 1893*—Continued.

PACIFIC COAST DIVISION—Continued.

States.	May. Weather.	May. Temperature.	May. Combined.	June. Weather.	June. Temperature.	June. Combined.	July. Weather.	July. Temperature.	July. Combined.	August. Weather.	August. Temperature.	August. Combined.
North California	93·9	71·6	85	99·3	73·3	88·9	99·4	86·1	94·1	100	76·5	90·6
South California	99·4	76·8	90·4	99·7	74·3	89·5	99	74·2	89·1	100	78·7	91·5
Arizona	96·8	84·8	92	100	81·7	92·7	94·2	85·2	90·6	81·9	77·4	80·1
Nevada	91·3	69·7	82·7	99·3	69	87·2	96·4	80·3	90	97·4	70	86·4
Utah	92·3	86·1	89·8	96·7	71	86·4	100	78·4	91·4	91·3	73·5	84·2
Oregon	77·4	81	78·8	89	59·7	77·3	94·5	77·8	87·8	95·5	70	85·3
Washington	65·8	76·8	70·2	84	65·3	76·5	95·5	76·1	87·7	91·3	71	83·2
Average	88·1	78·1	84·1	95·4	70·6	85·5	97	79·7	90·1	93·9	73·9	85·9

States.	September. Weather.	September. Temperature.	September. Combined.	October. Weather.	October. Temperature.	October. Combined.	November. Weather.	November. Temperature.	November. Combined.	December. Weather.	December. Temperature.	December. Combined.	Year. Weather.	Year. Temperature.	Year. Combined.
North California	88·7	68·3	80·5	93·2	74·2	85·6	88·7	74·3	82·9	94·8	75·8	87·2	92·1	75·2	85·3
South California	100	80	92	97·7	65·5	84·8	90·7	68·3	81·7	88·7	81·6	85·9	96·3	73·1	87
Arizona	93·3	60·3	80·1	97·7	67·1	85·5	97	73·7	87·7	95·2	85·2	91·2	94·2	77·7	87·6
Nevada	96	69	85·2	95·8	69·4	85·2	86	69·3	79·3	91·6	64·2	80·6	91·7	69·2	82·7
Utah	90·7	83. 7	87·9	98·4	64·5	84·8	91·7	68	82·2	88·7	68·7	80·7	89·4	75·3	83·7
Oregon	90·3	62·7	79·3	89	76·5	84	92	74·3	84·9	79	73·2	76·7	85·2	72·7	80·2
Washington	88·7	71·3	81·7	84·2	74·2	80·2	89·3	78·3	84·9	80·3	65·8	74·5	83·1	73·8	79·4
Average	92·5	70·8	83·8	93·7	70·2	84·3	90·8	72·3	83·4	88·3	73·5	82·4	90·3	73·8	83·7

Table II.—*Percentages of justifications of wind signals for the year ending December 31, 1893.*

Month.	Total number ordered.	Justified as to velocity.		Justified as to direction.	Cautionary.			Storm.			For easterly winds.		For westerly winds.		Number of winds without signals.	Number of signals ordered late.	Percentage of justification.
					Number ordered.	Justified as to velocity.		Number ordered.	Justified as to velocity.								
		Wholly.	Partly.			Wholly.	Partly.		Wholly.	Partly.	Ordered.	Justified.	Ordered.	Justified.			
Jan	217	137	0	197	0	0	0	217	137	0	73	53	144	144	8	5	72·3
Feb	191	154	2	184	0	0	0	191	154	2	53	47	138	137	8	18	83·2
Mar	180	131	4	159	0	0	0	180	131	4	61	54	119	105	10	10	76·3
Apr	338	257	21	335	63	46	13	275	211	8	143	142	195	193	21	15	83·7
May	225	177	19	212	122	95	13	103	82	6	94	88	131	124	14	12	83·9
June	128	87	0	118	78	47	0	50	40	0	53	49	75	69	23	5	70·4
July	36	29	0	35	30	23	0	6	6	0	12	11	24	24	24	3	63·9
Aug	94	75	0	88	0	0	0	94	75	0	79	73	15	15	7	1	82
Sept	143	93	2	136	82	59	1	61	34	1	68	64	75	72	26	15	68
Oct	336	214	2	315	156	95	1	180	119	1	177	166	159	149	5	11	74·5
Nov	300	200	19	268	148	80	12	152	120	7	113	97	187	171	33	30	71·5
Dec	244	181	12	221	64	43	10	180	138	2	73	57	171	164	26	43	74·1
Total	2, 432	1, 735	81	2, 268	743	488	50	1, 689	1, 247	31	999	901	1, 433	1, 367	205	168	*76·3

* Yearly percentage.

TABLE III.—*Percentages of justifications of cold-wave signals for the year ending December 31, 1893.*

Month.	Number of signals ordered.	Number verified.		Number of cold waves without signals.	Percentage of justification.
		Wholly.	Three-fourths.		
January	639	360	40	3	56·2
February	295	210	17	16	73·5
March	224	180	17	11	84
April	150	75	10	0	55
May					
June					
July					
August					
September					
October	38	20	4	0	60·5
November	229	136	18	0	65·3
December	427	318	22	16	76·9
Total	2,002	1,299	128	46	*68·9

* Yearly percentage.

TABLE IV.—*Percentages of verifications of forecasts by classes, for the year ending December 31, 1893.*

Month.	Twenty-four hours.								Forty-eight hours.							
	Weather.				Temperature.				Weather.				Temperature.			
	Fair.		Rain or snow.		Warmer or colder.		Stationary.		Fair.		Rain or snow.		Warmer or colder.		Stationary.	
	No.	Per ct. of ver.	No.	Per ct. of ver.	No.	Per ct. of ver.	No.	Per ct. of ver.	No.	Per ct. of ver.	No.	Per ct. of ver.	No.	Per ct. of ver.	No.	Per ct. of ver.
Jan	956	89·9	346	67·2	1,049	80·4	253	83·1	8	93·8	31	68·1	31	88·1		
Feb	527	90·7	649	82·1	1,003	87·1	173	76·4	17	93·5	18	83·9	41	72·7		
Mar	598	93·7	704	80·2	1,015	85·2	287	80·5	22	91·8	26	70	42	97·9	6	66·7
Apr	703	88·4	557	76	891	84·1	369	78·6								
May	1068	88	234	77·6	635	83·3	667	81·9								
June	767	89·2	493	74·7	852	80·6	408	81·7								
July	748	89·2	554	72·4	793	82·4	509	81·6	6	88·3			19	33·2		
Aug	664	90	638	56·8	928	64·3	374	78·6	83	75·2			114	72·9		
Sept	921	90	339	73·6	691	83·7	569	89·1	43	98·8						
Oct	938	95·1	364	77·6	959	79·7	343	85·3			1	30	19	15·8		
Nov	788	93·3	472	71·1	959	88·8	301	84·9	4	100	22	58·2	51	92·9		
Dec	882	89·8	420	81·1	1,073	87·2	229	81·4	17	100						
Totals	9,560	*90·4	5,770	*74·1	10,848	*82	4,482	*82	206	*87	98	*68·9	317	*75·1	6	*66·7

* Yearly percentage.

TABLE V.—*Percentages of verifications of 24-hour forecasts by classes, for the year ending December 31, 1393.*

[Pacific Coast division.]

Month.	Weather.				Temperature.			
	Fair.		Rain or snow.		Warmer or colder.		Stationary.	
	No. of forecasts.	Per cent of verification.	No. of forecasts.	Per cent of verification.	No. of forecasts.	Per cent of verification.	No. of forecasts.	Per cent of verification.
January	168	94·9	42	69·7	140	60·7	70	92·6
February	116	91·9	78	70·6	141	75	53	87·7
March	96	92·5	121	76·5	151	70·1	66	85·2
April	126	96·2	84	74·5	124	69·5	86	78·1
May	165	94·6	52	67·5	168	77·4	49	80·6
June	189	98·4	21	69	162	68·3	48	78·5
July	201	98·7	16	76·3	114	75	103	85
August	183	98·4	34	69·7	151	68·9	66	83·8
September	164	97·5	46	74·8	164	65·7	46	88·9
October	162	98·5	55	79·6	191	66·4	46	88·9
November	129	96·1	81	82·2	179	69	26	98·1
December	130	97·6	87	74·5	156	68·8	61	85·6
Totals	1,829	*96·6	717	*74·6	1,841	*69·4	705	*85·4

* Yearly percentage.

FORECASTS, STORM WARNINGS, AND COLD WAVES.

The attention of the employees of the Bureau has been fixed still more strongly than before upon the work of forecasting—the primary duty of the Bureau in its relation to the public.

The forecasts from the 8 a. m. and 8 p. m. observations have been made as usual throughout the year, the separate States and districts for which they are made numbering 45 and covering the entire country east of the Rocky Mountains. The forecasts are made habitually for periods of twenty-eight and thirty-six hours, respectively, and for longer periods when warranted.

Storm warnings to lake and seacoast stations and to the director of the Canadian meteorological service at Toronto, warnings of frost to the sugar, fruit, cranberry, and tobacco regions, and warnings of severe local storms, cold waves, northers, and dangerous floods to the threatened districts, have been issued whenever the conditions justified them.

An unusually large number of storm warnings have been sent out during the year, and with marked success. The past summer was one of unusual frequency in the occurrence of severe local storms and tornadoes, and warnings of the conditions favorable to these were given in nearly every instance. The cyclones of August 25–27 and October 12–14 were of marked violence and followed an exceptional path, but the action taken by this Bureau to give notice of their approach was such that nearly every interest affected received ample warning, and hearty commendations were received from the people in the districts over which they passed.

The warnings of the approach of cold waves have also been unusually successful during the year, abundant testimony having been received of their increased value and the large amount of perishable products saved thereby.

On July 1, 1893, the old forecast room, telegraph division, and river and flood room were consolidated into the forecast division and placed in charge of the assistant chief of the Bureau, thus enabling the Bureau to dispense with the services of a superintendent of telegraph, at a salary of $2,000, and a professor in charge of the river and flood room, at a salary of $2,500. The superintendence of the wind-signal-display stations and of the lake marine section has also been assigned to this division.

The staff of forecast officials has been assigned to this division, and during the months when they are not on official forecast duty they are required to make daily, for practice, complete forecasts from the a. m. map, employing also a portion of their time in the investigation and preparation of reports upon practical meteorological problems that have been officially assigned them. It is expected that these reports, several of which have been completed, will be of great value as practical aids to forecasting.

The system of giving each of the local forecast officials in the service a two months' course of instruction at this office in the preparation of the charts in use here and in making forecasts for the whole country has been resumed, there being some of these who were recently appointed who have not yet had this valuable training.

Arrangements have been made with the Light-House Board and the Superintendent of the Life-Saving Service whereby the keepers of the light-houses and life-saving stations on the Atlantic coast will telegraph this Bureau during the hurricane season the occurrence of heavy ocean

swells or other signs of the approach of hurricanes to our coast observed by them, these officials being exceptionally well located for this purpose. An instance of the value of these reports occurred during the hurricane that struck our southern coast in the latter part of August, 1893, when a report of a heavy ocean swell off Tybee Island, forwarded by telegraph by our observer at Savannah, was among the earliest intimations that we received of its approach.

RIVER AND FLOOD SERVICE.

The river and flood service has been reorganized by putting the making of the forecasts of river stages and changes in the hands of experienced observers at the principal river stations, assigning to each one a section of the river or rivers in his vicinity to forecast for. The observers are furnished with all the available data relative to the conditions of the rivers during the previous floods, and directed to make a careful study of the same. They receive daily telegraphic reports of the stages of rivers and amount of rainfall throughout their sections. These, with their own experience and the aid of such rules as have been found to be of practical value in river forecasting will, it is thought, enable them to make more valuable predictions than have hitherto been made under the old system, and the familiarity with the local needs will enable them to specialize more intelligently and distribute the warnings more effectively.

The efficiency of the storm-warning system on the Great Lakes has been considerably increased by the establishment of 10 new display stations, and decided progress has been made in the work of ascertaining the set of, and charting, the lake currents. A large number of bottles have been floated during the season for this purpose, and a preliminary current chart, as a result of the work for 1892, has been prepared and published.

The investigation of the meteorological conditions that prevail over the Great Lakes has also been greatly extended, over 100 new voluntary observers having been secured from among the masters of lake vessels. The collection of the data in relation to the currents and meteorology of the Great Lakes has entailed very little expense to the Government, and it is expected that it will prove of great value to the lake marine.

REPAIR OF SEACOAST TELEGRAPH LINES.

Under the head of maintenance and repairs of seacoast telegraph lines the most important feature was the completion in July last of the telephone lines and cables connecting Thunder Bay and Middle Islands, in Lake Huron, with the Weather Bureau office at Alpena, Mich., thus permitting the establishment of display and vessel-reporting stations on these islands. The line to Thunder Bay Island is $17\frac{3}{8}$ miles long, inclusive of $3\frac{3}{8}$ miles of submarine cable; that to Middle Island, $13\frac{3}{4}$ miles, with $2\frac{1}{8}$ miles of cable. Both lines were put in operation July 14, 1893, and have worked without material interruption since that date.

Extensive general repairs were made on the Tatoosh Island, Fort Canby, and Hatteras sections, with excellent results. The work on the first-named section consisted mainly in clearing out trails through the dense forest and underbrush to facilitate the movements of repairmen,

and in changing portions of the line to prevent damage from landslides. Two additional repair stations were established along the line, which, it is hoped, will greatly lessen the frequency and duration of interruptions as compared with last year. The exceedingly rough character of the country, absence of roads, prevalence of high winds, etc., render the efficient maintenance of this line a difficult problem at all times, justified only by its great and growing importance to the shipping interests of Puget Sound and the North Pacific coast. The following extract from the report of the inspector who visited Tatoosh Island last October may be of interest in this connection:

> Since September 1 all tug boats from the sound (Puget Sound) receive orders from their owners from this station by telegraph. It is a great advantage to the shipping interests. A large blackboard is in course of construction and is to be placed on the bluff, and messages to be written in large letters so that they can be read with a glass, thus saving time and expense to vessels passing in or out. Shipping reports, weather and vessels, are sent by telegraph three times a day to Port Angeles, Port Townsend, and Seattle. A record of all vessels passing in or out is prepared by the observer.

On the Hatteras section 1,169 new wooden telegraph poles were put up, and the entire line given a general overhauling. The chief operator at Cape Henry reports that this work was done in an entirely satisfactory manner, and that the line is now in excellent condition, except that (owing to the damage done by the cyclones of August and October last) 25 additional poles and 12 miles of new wire should be used to strengthen certain weak places. The south-shore end of the New Inlet (North Carolina) cable was lengthened by 122 yards, to prevent a threatened washout. The cable between Cape Henry and Cape Charles was broken during January. Efforts to recover and splice the broken ends having proved fruitless, the honorable Secretary authorized the abandonment and subsequent sale of this cable, which, at best, had been of little direct value to the public service. The following extract from the chief operator's line journal, dated Cape Henry, September 14, 1893, gives an example of some of the services rendered by the Hatteras line:

> By request of the commandant of the Norfolk navy-yard, the United States cruiser *Detroit* was to-day flagged and instructed by this office to return to Hampton Roads. The vessel was bound to Rio de Janeiro, Brazil, but orders had been issued by the Navy Department deferring the cruiser's departure until after her final trial trip. When the telegraphic order reached Hampton Roads and Norfolk the vessel was beyond the reach of communication by the usual methods, but upon Admiral Brown requesting the assistance of the Bureau in his efforts to overhaul the steamer, prompt action was taken on his request, with the result that the *Detroit* was back in Hampton Roads at noon.

The line from Titusville to Jupiter was prostrated and badly damaged by the cyclone of October 13. As the northern portion of this line had already been duplicated by a railroad telegraph line now under construction between Titusville and Jupiter, with the expectation that the entire distance would be covered by the road by February next, no expense was authorized for rebuilding the Government line. Under an agreement between the Chief of the Bureau and the railroad company the latter has rebuilt the southern half of the line, with the privilege of using the same until its own wire reaches Jupiter, when the entire Government line can be put up for sale at auction.

Less extensive general repairs were also made necessary during the year on the Nantucket, Wilmington, and Point Reyes sections. At this date all lines are reported to be in good condition for the winter.

The entire mileage of telegraph lines and submarine cables is 645, of

which 166 miles, in 3 sections, are on the Pacific coast; 488 miles, in 5 sections, on the Atlantic coast, and 1 section of 31 miles on Lake Huron.

With reference to the other duties of the telegraph service, it may be mentioned that in making contracts for the present fiscal year a reduction of about 12½ per cent was obtained on telegraph rates for the Bureau.

STATE WEATHER SERVICES.

The year 1893 has been one of much activity in State weather service work. Before the close of 1892, as stated in the last Annual Report of the Secretary of Agriculture, State weather service organizations had been so extended as to cover the whole of the United States, the last service organized being that for Idaho. The entire field being thus covered, the work of the year 1893 has been in the direction of further developing and improving the services already in operation.

That the popularity and usefulness of the State weather service is becoming more fully recognized as the work of these organizations becomes more generally known is attested by the fact that during the past year the legislatures of New York, Pennsylvania, and North Dakota have made liberal provision for the support of their respective services. As New York and Pennsylvania had in former years made provision for their services, the continued aid thus given is evidence of proper recognition and appreciation of the value of the work performed. The work accomplished by the Maryland State service during the year was so effective that the governor, whose approval of the bill for the support of that service was given only upon condition that but one-half of the sum appropriated should be expended, withdrew his objections and authorized the expenditure of the full amount of the appropriation ($2,000) in carrying on the work of the service. It is believed that during the ensuing year the legislatures of other States, recognizing the importance of the State weather services, will provide for their maintenance.

STATION OFFICERS AND TRANSFERS.

Owing to pressure of other professional duties, Prof. P. H. Mell, who organized the Alabama weather service in 1884, with headquarters at Auburn, found it impracticable to continue longer in charge of that service, and on July 1, 1893, retired from the directorship. Under Prof. Mell's management the Alabama weather service, which was among the first to begin active coöperation with the National Bureau in the distribution of weather forecasts, became one of the most efficient local weather services in the country. Upon the resignation of Prof. Mell the central station of the Alabama service was transferred from Auburn to Montgomery and placed under the charge of an official of the Weather Bureau. Montgomery being centrally located, with better facilities for communication than exist at Auburn, the future prospects of this State service are most encouraging. The central station of the Nebraska weather service has also been transferred from Crete to Omaha. This change was made in view of the superior facilities for the printing and distribution by mail and telegraph of the information collected by the State and National services. By this transfer of the central station to Omaha Prof. Goodwin D. Sweezey retired from the directorship and was succeeded by the official in charge of the regular Weather Bureau station at Omaha.

The same reasons that prompted the Chief of the Weather Bureau in ordering the transfer of the central stations of the Alabama and Nebraska services—viz, to secure improved facilities for the collection of meteorological and crop data and for the distribution of the weather forecasts and other information—also caused the transfer of the central station of the Mississippi service from University to Vicksburg, and that of the Washington weather service from Olympia to Seattle. While these changes in the locations of the central stations of the Alabama, Mississippi, Nebraska, and Washington weather services will make it possible to accomplish much more efficient work in those States, this action involved the loss of the services of the directors of the Alabama, Mississippi, and Nebraska weather services, respectively; but they have been succeeded by men of experience and ability, who will earnestly endeavor to further improve and extend the work.

At the close of the year the transfer of the central station of the Virginia service from Lynchburg to Richmond is under advisement, and it is probable that the change under consideration will be made before the opening of the crop season of 1894. By the proposed transfer it is expected that a closer coöperation between the State service and the State board of agriculture will be secured to the mutual advantage of both State and National services.

WEATHER CROP BULLETINS.

The weather crop service continues to be the most valuable feature of State weather service work. All State weather services, except that of Nevada (in which State the principal work has been the collection and publication of meteorological data, owing to the limited extent to which agricultural pursuits are carried on), have issued weather-crop bulletins during the season of planting, cultivating, and harvesting of crops. These State weather crop bulletins are based upon impartial and reliable reports on the weather and crop conditions each week during the season, the report being so mailed as to reach the State service center Monday afternoon, or early Tuesday morning, and as a rule to cover as nearly as possible the week ending Monday. The correspondents are so distributed that their reports furnish the official at the State center full information as to the weather and crop conditions of the State, from which he is enabled to prepare the State bulletin containing a review of the conditions prevailing during the previous week. During the season of 1893 the number of weather crop correspondents was increased by more than 100 per cent over the number of the previous year, there being at the midst of the season more than 9,000 crop correspondents coöperating with the several services throughout the country.

The circulation of the weekly weather crop bulletins of State services has also greatly increased, the weekly editions of as many as ten services ranging from 1,000 to 11,000 copies; the others for the most part closely approximating the first-named figure. While this distribution of the bulletins insures wide publicity of the information they contain, the press of the country affords by far the most effective means of distribution, as the bulletins are printed in a large proportion of the weekly and daily papers and in many agricultural journals throughout the country. As an illustration of the extent to which the State bulletins are circulated through the public press, it may be stated that the Missouri and Arkansas bulletins are reprinted in nearly 200 patent-

sheet weeklies having an aggregate circulation of more than 150,000 copies.

As the National Weather Crop Bulletin, issued at Washington, is based upon the information received by telegraph from the various State centers, and as there has been such a general and decided extension of this work in all States, the data composing the National Bulletin has been more complete than in any previous year. The demand for this publication continues, and during the year arrangements were made for the public display of the bulletin in more than 130 cities and towns of more than 5,000 inhabitants, through the coöperation of mayors, postmasters, and other officials. From the temperature and precipitation charts accompanying the National Bulletin may be readily seen how the current weekly temperature and rainfall compare with the normals deduced from observations covering long periods. The reproduction in agricultural journals of the National Weather Crop Bulletin and special charts of temperature and rainfall, a work referred to in the last annual report, has been continued this season with the same success that attended similar work last year.

The former excellent character of the monthly reports of State weather services has been fully maintained during the year, and the general increase in the number of voluntary observers, upon whom these reports so largely depend, has afforded more than the usual amount of material for discussion and investigation. The detailed climatological data published in these reports render them of much value. During the past summer it was found that the representatives of foreign meteorological services in attendance at the Columbian Exhibition, in calling at the Weather Bureau in Washington manifested great interest in the State weather service system, and were anxious to secure specimen copies of the publications issued.

WEEKLY SNOW CHART.

During the latter part of January, 1893, the publication of a chart of the size of the daily weather map, showing the depth of snow on the ground at 8 p. m. of Monday of each week, was commenced at this office, based upon telegraphic reports made at the hour named, by the observers of the Bureau. The first issue of this snow chart was that for the week ending January 23, 1893, and it was regularly published each week thereafter until the close of the winter. The favor with which this chart was received has induced the Chief of the Bureau to make it a permanent publication during the winter season. Its publication for the winter of 1893–'94 was resumed December 5, and in addition to illustrating in graphic manner the depth of snow on the ground, the detailed reports of which are given in tabular form, provision was also made for publishing, in connection with this chart, information as to the thickness of ice in the various rivers and harbors at Weather Bureau stations. The snow charts issued during the winter of 1892–'93 were reproduced by chalk-plate process in the columns of a number of the larger newspapers in different sections of the country. When the protection afforded winter wheat by a covering of snow is considered, it will readily be seen why such interest would be taken in a publication that shows at a glance the extent and depth of snow during the winter. This snow chart is also of great importance to the lumber interests of the Northwestern States. Mr. James F. Buckner, secretary of the Louisville (Ky.) Board of Trade, in a communication addressed

to the observer at Louisville, under date of January 28, 1893, referring to this chart, states as follows:

Referring to your note of the 26th instant, inclosing copy of chart showing snowfall up to 8 o'clock p. m. Monday, the 23d instant, I have to say that I have examined the chart carefully and have called to it the attention of a considerable number of the members of the board of trade, who are interested in such matters, and our unanimous opinion is that it is a most valuable publication, in fact one of the very best issued by your Bureau, and we sincerely hope that the Department will continue to send it. The chart is of especial interest to quite a large number of the members of this board of trade who are engaged in milling and dealing in grain (wheat) generally.

The Chief of the Bureau is also in receipt of numerous other communications commending the snow chart.

SPECIAL THUNDERSTORM OBSERVATIONS.

The collection of special thunderstorm observations, after the plan followed during the summer of 1892, was continued this year, the region of observations being extended to include the territory east of the 100th meridian, north of the 35th parallel. A large number of observations were collected during the months of June, July, and August, an investigation of which is now being conducted.

VOLUNTARY OBSERVERS.

The total number of voluntary stations established during the year ending June 30, 1893, was 540. Of these over 300 were fully or partially equipped with instruments of the Bureau. About 50 per cent of the remainder, or about 100 stations, were furnished with instruments by the several State weather services, while the personal property of the observers formed the equipment of the rest. The total number of voluntary observers is about 2,500, including Army post surgeons and agents of the Central and Southern Pacific Railroad systems.

THE COTTON REGION SERVICE.

The cotton region service, which was placed under this division in July, has been continued as in former years, the observers taking one observation daily of rainfall and extremes of temperature, and telegraphing the same to the several centers. The present organization of the cotton region service is very complete in most of the cotton-producing States, but a larger number of stations in Texas would materially improve the service in that State.

CONVENTION OF WEATHER SERVICE OFFICIALS.

The important work now being conducted by State weather services throughout the country makes it very desirable that the officials of these services should meet in convention for the purpose of exchange of views and discussion of various matters of importance in connection with their work. Such a convention was held in Rochester, N. Y., in 1892, when a permanent organization, known as the "American Association of State Weather Services," was formed. The second convention of this association was held in Chicago, August 21-25, 1893, an abstract of the proceedings of which was published in the Monthly Weather Review of August, 1893.

THE DISTRIBUTION OF FORECASTS, AND FROST, COLD-WAVE, INLAND-STORM, AND RAIN WARNINGS.

In the distribution of weather forecasts and special warnings every available means of transmission is being utilized; and while the number of stations receiving such weather information by telegraph or telephone at Government expense has been materially decreased during the year, the number of places to which forecasts, etc., are furnished at little or no cost to the Bureau has been largely augmented. The number of stations now receiving the full forecasts by telegraph or telephone at Government expense is 1,613—a reduction of 275 during the past year; and the number of places receiving the same information through gratuitous distribution is over 7,000—an increase of over 3,000 during the same period. Plans have been perfected for an extended distribution of the forecasts by mail, and the total number of places receiving such information will be largely increased in the near future, as it is expected that, through the voluntary coöperation of the interested persons, this Bureau will, during the coming year, be enabled to have its forecasts posted in many thousands of post-offices within agricultural sections which have not heretofore received the benefit of such information.

COÖPERATION OF RAILROAD COMPANIES.

A large number of railroad companies are coöperating with this Bureau in the work of distributing the forecasts by telegraphing the same over their lines (in some cases twice daily), and as a rule require prompt and proper attention on the part of their employees concerning the receipt and posting of the weather telegrams. Other railroad companies are performing this service gratuitously through the medium of train baggage masters, who distribute the bulletins to station agents, and they in turn post the information for the benefit of the public. Weather symbols are displayed on the baggage cars of the following railroads: Chicago and Grand Trunk; Chicago and West Michigan; Grand Rapids and Indiana; Pontiac, Oxford and Port Austin; Chicago and Rock Island.

Over 400 full sets and nearly 100 partial sets of weather signal flags were furnished to displaymen by this Bureau during the past year.

The whistle signals are used to a considerable extent in some States. In the State of Ohio alone the use of the stationary engine as a means of disseminating weather forecasts has constantly increased in favor, and over 50 towns in that State are now sounding the weather forecasts daily. These points alone represent over 200,000 farmers within the limits of hearing of the signals. The usefulness of this method of service is beyond expectation, as is also its appreciation.

FORECASTS AND WARNINGS DISTRIBUTED.

The following tabulated statement shows the number of places supplied with forecasts and special warnings by paid service and without expense, and is arranged with a view to comparison of the work of distribution in each State and Territory:

Distribution of forecasts, cold-wave, and frost warnings.

States and Territories.	By telegraph or telephone, at Government expense.			Without expense to the United States, by—			
	Forecasts and warnings.	Cold-wave warnings only.	Frost warnings only.	Mail.	Telegraph or telephone.	Railroad telegraph.	Railroad train service.
Alabama	19			218	1	4	53
Arizona	1						
Arkansas	24	1	3		17	2	
California	55		4	16	24	26	
Colorado	15	5	7	2		4	7
Connecticut	12	4	4		47	33	4
Delaware	5					1	
District of Columbia	1						
Florida	18	1	18	180	9	13	
Georgia	44		39	66		56	82
Idaho	1						
Illinois	80	11	5	151	10	183	
Indiana	76	4		111		83	80
Indian Territory	5						
Iowa	72	11		100			
Kansas	49	3		100	23	91	3
Kentucky	39	6	43	1	3		
Louisiana	25	4	27	32	17		16
Maine	29	2	1	83	4	10	77
Maryland	18	1	3	4	7	70	
Massachusetts	15	5	16	13			305
Michigan	64	7		7	11	161	5
Minnesota	51	2	12	18	3		
Mississippi	35	5	10	47	50	67	14
Missouri	53	6	1	233	53		60
Montana	5				1		
Nebraska	46	4		140		11	
Nevada	2						
New Hampshire	20	1		113	8	3	31
New Jersey	28	5	22	55	14	159	
New Mexico							
New York	97	27	15	267	115	236	155
North Carolina	55	2	24	246	8		16
North Dakota	16	3	14		1		
Ohio	104	4	94	437	57	53	
Oklahoma Territory	3	1					
Oregon	27			4			107
Pennsylvania	65	15	1	136	85	709	7
Rhode Island	3	1		3			27
South Carolina	50	7		52	11	20	
South Dakota	44	9	14	5			
Tennessee	20	1	24	39	19	20	92
Texas	40	3	14	15		4	
Utah					6	4	
Vermont	12			106	8	12	4
Virginia	25	3	11	8		54	88
Washington	19		3				31
West Virginia	18	1	11		1	40	
Wisconsin	108		18	57	7		
Wyoming		9					
Total	1,613	174	458	3,065	620	2,129	1,264

Grand total, 9,323.

INSTRUMENTS.

The work inaugurated a few years since of improving very much the instrumental equipment of stations by providing them with instruments furnishing continuous and automatic records, and the development and improvement of the instruments themselves, have been prosecuted throughout the year with very gratifying results.

There are now in use at the stations the following special instruments: 69 registers, recording wind direction, velocity, and, in some cases, rainfall and sunshine; 90 registers, recording wind velocity; 70 barographs, 88 thermographs, recording pressure and temperature, respectively; 19 photographic sunshine recorders, to which have been recently added 24 electrical recorders of sunshine, and 10 recording rain and snow gauges.

Among the instruments specified above special improvements in respect to various details of construction have been made in the devices for securing registration of wind direction and velocity. The instruments for recording rain and snowfall and for securing an electrical registration of sunshine were devised during 1892, and greatly developed and rendered practically applicable to station work during the current year.

The correspondence growing out of the supervision of the instrumental equipment of stations and the routine duty of inspection of records from recording instruments has been promptly disposed of without increase in the number of employees, notwithstanding the very great increase in the volume of the work incident to the enlarged and elaborated equipment of stations.

The introduction of continuously recording instruments at our stations marks an important step in advance, not only in accumulating data of great climatic value, but in supplying the needs of great business and commercial interests by having complete automatic records of storms and general meteorological conditions at all hours, day and night. Without such instruments, and with eye observations in the morning and evening only, it was never possible to give accurate reports of special meteorological conditions of great importance to engineers, builders, shippers, etc., or to courts of justice.

By means of the improved devices we are using with great success at many stations we are able to obtain continuous records hour after hour, showing at each moment of time the direction of the wind, its velocity, the duration, moment by moment, of sunshine or cloudiness, the temperature of the air, the pressure of the air, the time of beginning and ending of rainfall or snowfall, and not only the total quantity of precipitation, but also whether the fall was rapid and in torrents or gentle and prolonged. Applications indorsed by boards of trade, engineers, and others are repeatedly received from many of the stations not yet equipped with these recording instruments, urging that this improvement of the service furnishing such valuable and important data be extended in their direction and developed to its greatest utility.

REPAIR OF DAMAGED INSTRUMENTS.

The great and increasing volume of work devolving upon the instrument room taxes to the utmost the present force available for its prompt performance. This is particularly the case in respect to the work of repairing damaged and unserviceable instruments. The nature of the work is such that it is impossible to accomplish it successfully outside the office, from the fact that the work is of the greatest diversity, requiring special provision for each particular case, and the best results can be obtained only under the immediate supervision of the official in charge of instruments. We now have on hand many old instruments, more or less damaged by use, that can be made serviceable by various repairs and modifications, and this work is being done in the machine shop. Only two workmen, however, are available, and the progress of repairs is very slow and tedious. Additional assistance is very greatly needed.

THE LIBRARY.

During the year ending June 30, 1893, there were added to the library 1,170 books and 653 pamphlets, or a total of accessions of 1,823 numbers, the largest number of meteorological books and pamphlets added in any one year since the organization of the Weather Bureau in 1870.

The books in the library now number 14,301 and the pamphlets 4,640. Only such books and pamphlets are added as bear upon the legitimate work of the Bureau. More than one-half of these are acquired by a system of exchange with home and foreign weather services, or by gift.

A valuable collection of patent specifications and drawings relating to meteorological instruments was obtained for the library from the Commissioner of Patents. This collection comprises over 400 numbers, and includes practically all patents of this class issued in the United States up to 1893.

As opportunity offered during the year titles were added to the general bibliography of meteorology, mostly from books and periodicals in the library of the Weather Bureau. The collection now comprises over 65,000 titles. The usefulness of this catalogue would be greatly increased by the publication of, at least, the portions relating to those branches of meteorology to which the Bureau is at present devoting special attention, i. e., weather forecasting and climatology.

RECORDS.

In any comprehensive system of meteorological observations a number of checks upon the accuracy of the work of each individual observer is necessary. The scheme of checking the accuracy of the observations made by Weather Bureau observers begins with the reports received twice daily by the translator. The entire mass of data charted on the daily weather map is subjected to his scrutiny, and steps are immediately taken to correct improbable entries and apparent inaccuracies. Later, when the manuscript observations are received, they are subjected to a further examination with a view of correcting the errors that naturally occur in reductions and compilations. It is especially gratifying to report that with but few exceptions the work in this respect is highly creditable.

Several hundred transcripts of records of meteorological observations have been made during the year for use as evidence in courts of law, and the records of outlying stations have been taken into court in a large number of additional cases. Many of these transcripts have been used in actions involving large sums of money, and it frequently happens that the turning point of the case hinges upon the state of the weather. Especially is this so in the case of transportation companies carrying perishable goods.

The twenty-third year of continuous meteorological observations under the auspices of the General Government was completed on November 1, 1893. In the beginning there was naturally more or less uncertainty as to the amount and character of meteorologic and climatic data that should be placed on record. Succeeding years, however, developed a tendency towards expansion, both as to the phenomena investigated and the details of observation. The maximum period of observations and record was reached in 1884, when direct observations of the weather alone were made and recorded 8 times each day. That number gradually decreased until at present the needs of the service are fully met with regular observations twice daily, supplemented by

such special observations as may be deemed necessary by the forecast official at the central office. The volume of records of direct observations is not so great, therefore, as at a previous period in the history of the metereorological service; but what is lacking in direct observation is fully compensated for in the number and character of automatic records now maintained. The latter serve a double purpose. They enable observers at outlying stations to keep themselves constantly informed of the atmospheric changes that are taking place hourly, and also to supply a growing demand for climatic data as affecting the varied interests of commerce and agriculture.

Continuous records of wind velocity have been maintained from 1871–1872 to date, and of late years an automatic record of the direction—a most important feature—has been added. A continuous record of velocity and direction is made at 69 stations and of velocity only at 90 stations.

The continuous climatic records, next in order as to number maintained, are those of temperature, 88 of which are now being made.

Thermographs were supplied to 38 stations in 1888, and additional instruments have been put into use from time to time until the present number has been reached.

Continuous records of rainfall were begun at 10 stations in 1889 and are now being made at 45 stations. Continuous records of pressure were begun at 5 stations in 1888; the number now being maintained is 70. Continuous records of sunshine began in 1891 at 20 stations; the number of such records now being maintained is 43.

The numerical results derived from the foregoing-named records as well as the results of direct observations are closely scrutinized in the records division and tabulated for publication in the Monthly Weather Review and other climatic reports.

PUBLICATIONS.

The character of the work of this division does not materially change from year to year, except in volume. During the present year the increase has been very marked, and the result has been that it has required careful attention and a large amount of labor in handling the enormous quantity of maps, bulletins, reviews, forms, and other publications issued from time to time for distribution to the general public, and to do the work in a business-like manner.

In the composing room are set up and printed the bulletins, monthly weather reviews, instructions, circulars, wrappers, letters and letter-heads, envelopes, many of the forms, and the miscellaneous matter of the Bureau. The volume of the work may be judged by the fact that 2,548,157 copies were made in the press-room. The number of lithographic impressions taken was 1,287,565, and during the year the number of forms issued to stations and the central office was 4,978,600, of which 830,550 were printed by the Bureau, the remainder by the Government Printing Office.

The Monthly Weather Review has varied in size from 28 to 46 pages, and in editions from 3,455 copies to 4,188.

In July, 1893, an edition of 5,000 copies of the Current Chart of the Great Lakes, in four colors, was issued. This work was performed in the lithograph room and was considered to be a first-class job in every respect, and was done at a small expense to this Bureau. This has only recently been rendered possible by our outfit. Lake Storm Bulletins Nos. 1, 2, 3, and 4 have also been printed, showing the storms

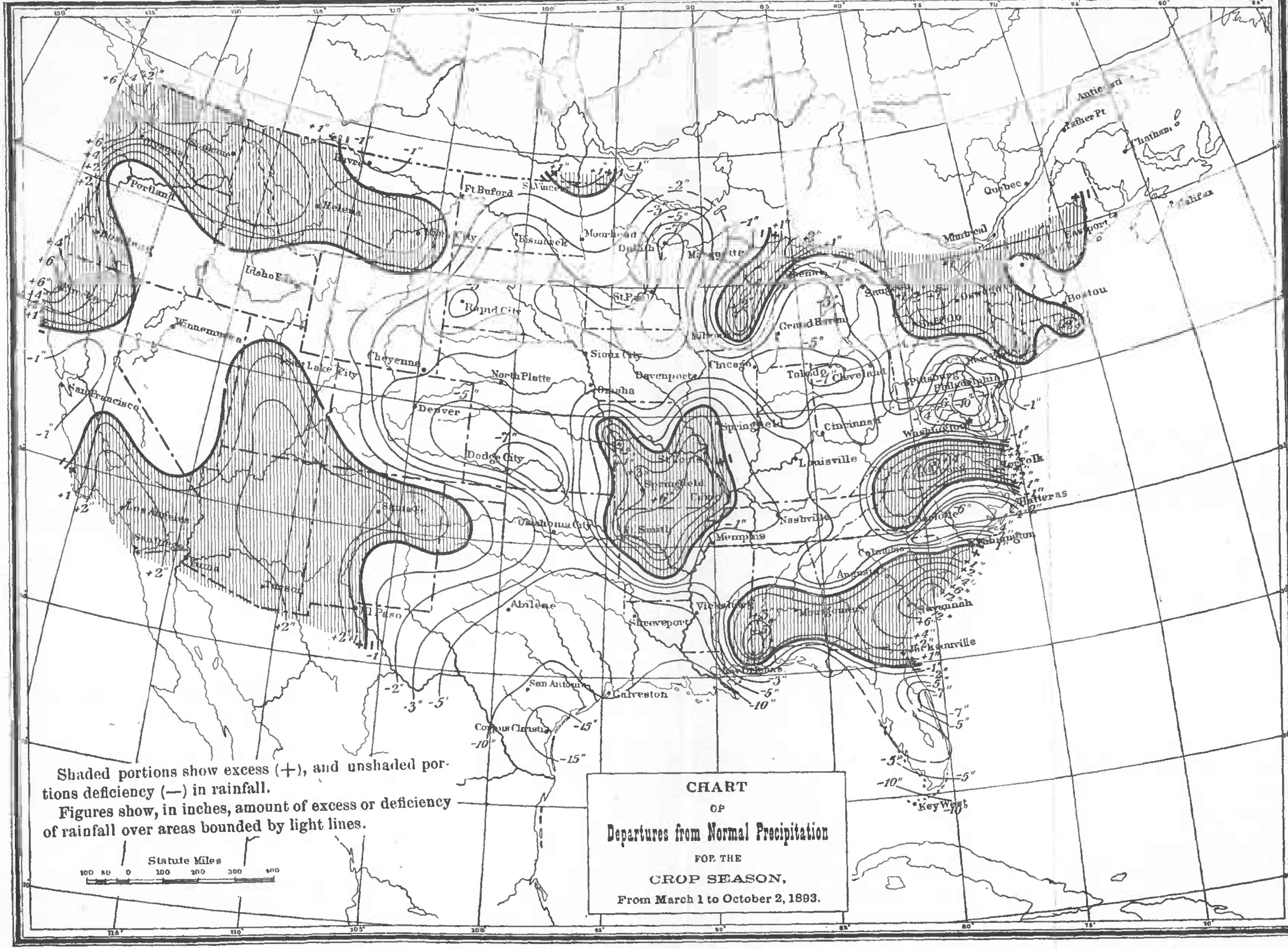


CHART
OF
Departures from Normal Precipitation
FOR THE
CROP SEASON,
From March 1 to October 2, 1893.
Shaded portions show excess (+), and unshaded portions deficiency (—) in rainfall.
Figures show, in inches, amount of excess or deficiency of rainfall over areas bounded by light lines.
Statute Miles
100 50 0 100 200 300 400
Portland
Helena
Havre
Ft Buford
Bismarck
Moorhead
Duluth
Marquette
Rapid City
St.Paul
Grand Haven
Winnemucca
Cheyenne
North Platte
Sioux City
Davenport
Chicago
Toledo
Cleveland
Pittsburg
Philadelphia
Salt Lake City
San Francisco
Denver
Omaha
Springfield
Cincinnati
Washington
Norfolk
Dodge City
St Louis
Louisville
Hatteras
Los Angeles
San Diego
Oklahoma City
Nashville
Memphis
Columbia
Augusta
Savannah
Jacksonville
Montgomery
Vicksburg
Shreveport
Abilene
El Paso
San Antonio
Galveston
Corpus Christi
Key West
Quebec
Montreal
Boston
Eastport
Halifax
Chatham
Father Pt
Anticosti

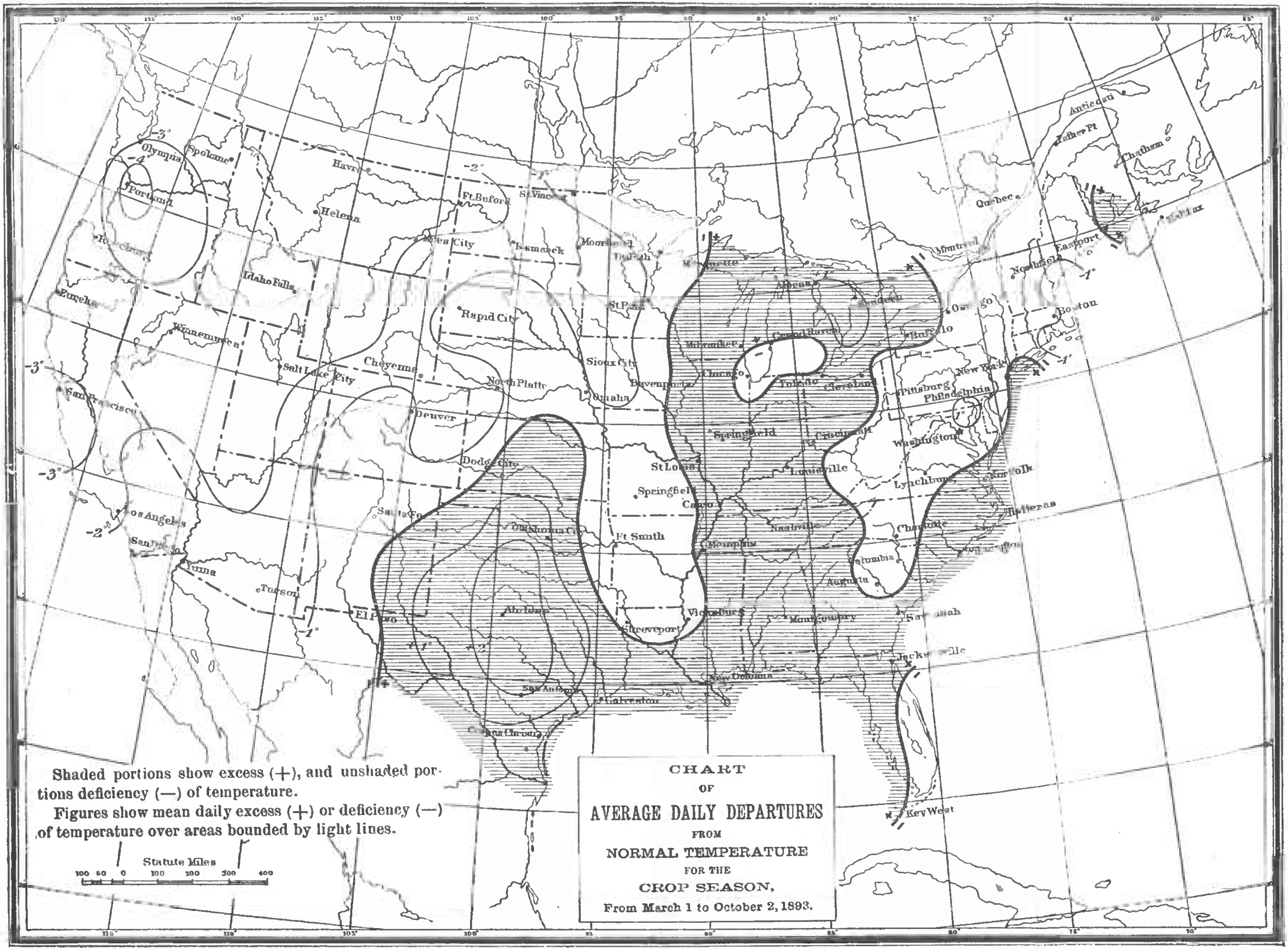
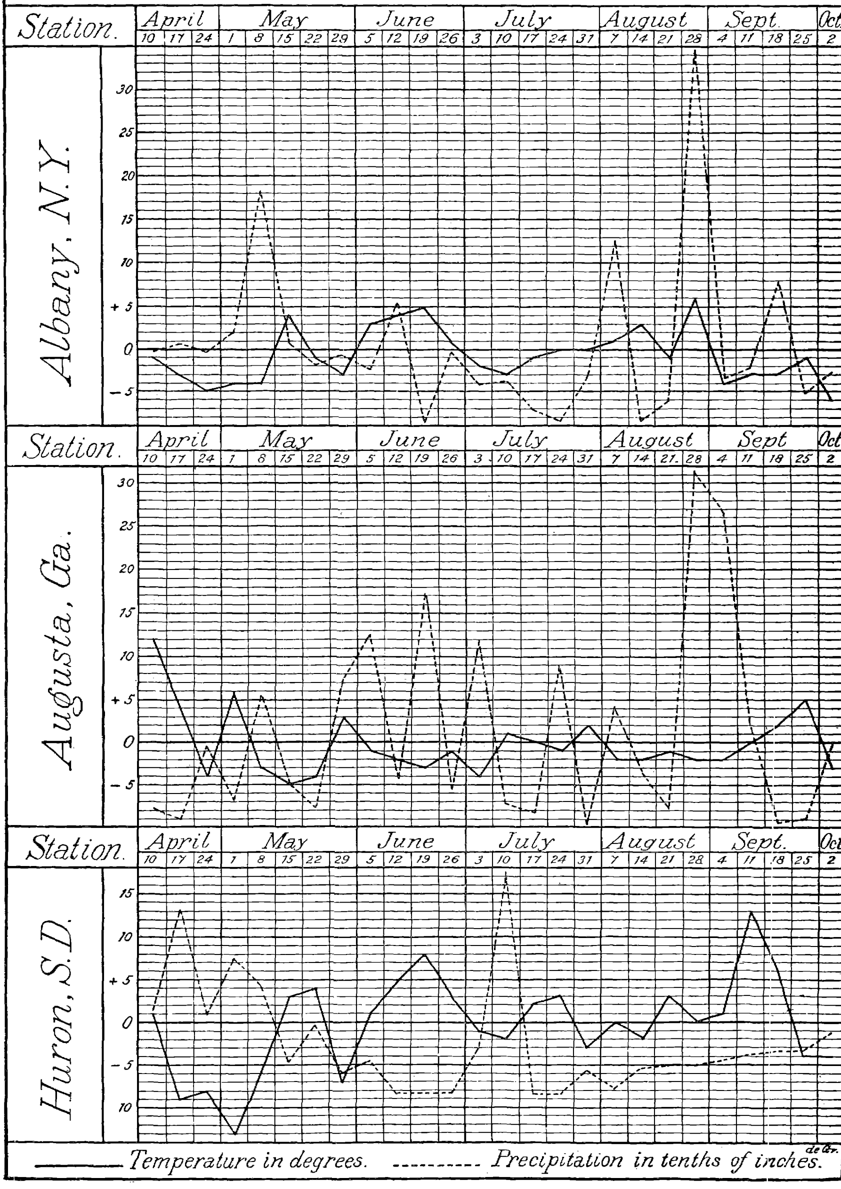
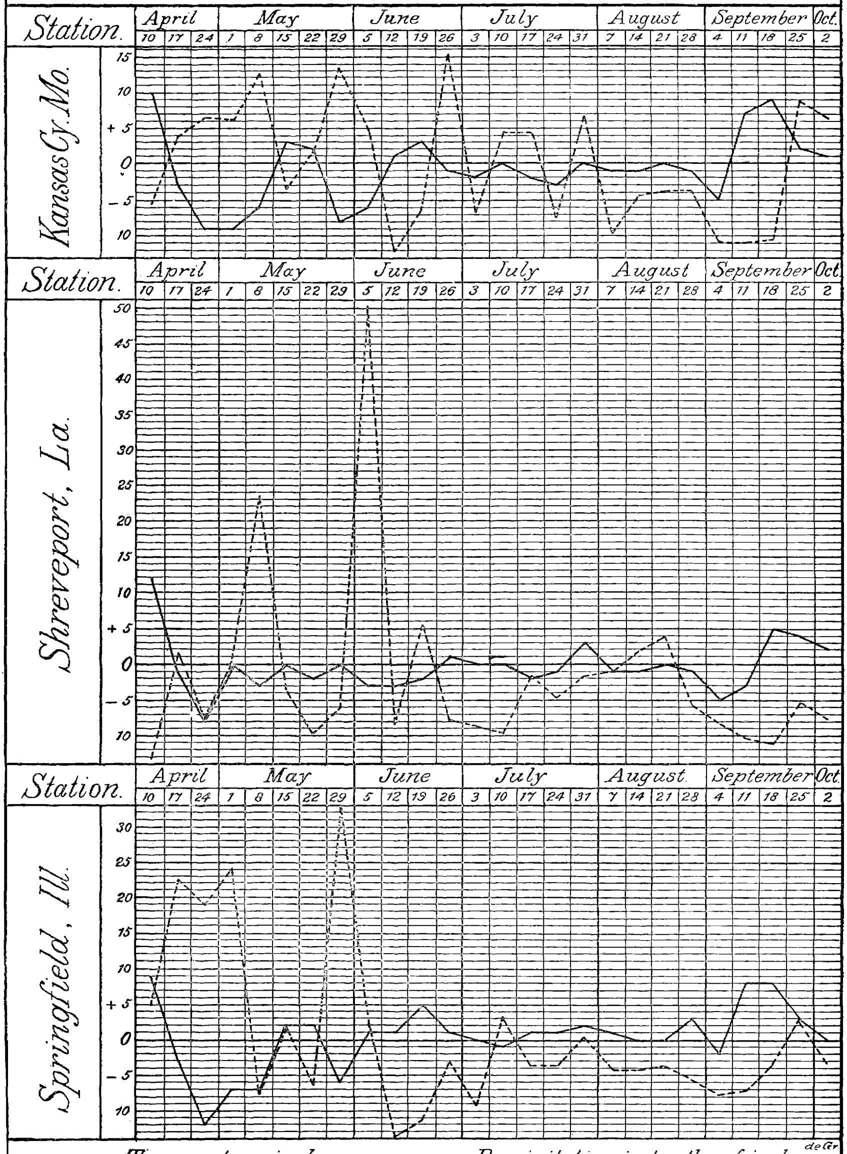


CHART
OF
AVERAGE DAILY DEPARTURES
FROM
NORMAL TEMPERATURE
FOR THE
CROP SEASON,
From March 1 to October 2, 1893.
Shaded portions show excess (+), and unshaded portions deficiency (—) of temperature.
Figures show mean daily excess (+) or deficiency (—) of temperature over areas bounded by light lines.
Statute Miles
100 50 0 100 200 300 400
Olympia
Spokane
Portland
Havre
Helena
Ft. Buford
Miles City
Bismarck
Moorhead
Idaho Falls
Eureka
Rapid City
St. Paul
Winnemucca
Salt Lake City
Cheyenne
North Platte
Sioux City
Omaha
Davenport
San Francisco
Denver
Dodge City
St. Louis
Springfield
Cairo
Santa Fe
Oklahoma City
Ft. Smith
Memphis
Los Angeles
Yuma
Tucson
El Paso
Abilene
Shreveport
Vicksburg
San Antonio
Galveston
Corpus Christi
New Orleans
Montgomery
Milwaukee
Chicago
Grand Haven
Toledo
Cleveland
Buffalo
Oswego
Pittsburg
New York
Philadelphia
Washington
Cincinnati
Louisville
Nashville
Lynchburg
Norfolk
Hatteras
Charlotte
Columbia
Augusta
Savannah
Jacksonville
Key West
Boston
Northfield
Eastport
Montreal
Quebec
Halifax
Chatham
Father Pt
Anticosti
-3°
-4
-2°
-1°
+1
+2

Average daily Departures from Normal Temperature, and weekly Departures from Normal Precipitation, from April 10th to October 2nd 1893.



Average daily Departures from Normal Temperature, and weekly Departures from Normal Precipitation, from April 10th to October 2nd 1893.



———— Temperature in degrees. - - - - - - Precipitation in tenths of inches.

of October 4 and October 5 to 14, 1893; also the storm of November 16 and 17, and the storms of November 20 to 23, 1893. The edition of these bulletins was 600 copies at first, but there being such a demand for them the edition had to be increased to 1,000 copies. They will be printed and distributed in the future whenever a noteworthy storm passes over the Lake region.

Five Weather Bureau bulletins were printed during the year, as follows:

	Copies.
Bulletin A. Summary of International Meteorological Observations, by Maj. H. H. C. Dunwoody. 10 pages of text and 61 charts	500
Bulletin No. 7. Report of the First Annual Meeting of the American Association of State Weather Services. 49 pages	6,500
Bulletin No. 8. Report on the Climatology of the Cotton Plant, by P. H. Mell, Ph. D. 68 pages with charts	7,500
Bulletin No. 9. Report on the Forecasting of Thunderstorms during the Summer of 1892, by N. B. Conger. 54 pages with charts	7,500
Bulletin No. 10. Report on the Climate of Chicago, by Prof. Henry A. Hazen. 137 pages with charts	5,000

WEATHER CONDITIONS OF THE CROP OF 1893.

(Prepared by H. H. C. Dunwoody, Major, Signal Corps, U. S. Army, assigned as Assistant Chief of Weather Bureau.)

The tabular statements (Tables VI and VII) show the temperature and rainfall from January 1, 1893, to April 3, compared with the normal for many years, and similar comparisons are made for these elements for each week ending with Monday from April 3 to October 2, 1893.

Plate I shows the seasonal conditions of rainfall from March 1 to October 2 throughout the United States. The shaded portion of this chart covers areas where the precipitation was in excess, and the unshaded portion shows the region of country that received less than the usual rainfall for the same period. The lines show the amount of excess or deficiency in inches, as indicated by the figures. It will be seen from this chart that the season of 1893 was dry over the greater portion of the agricultural districts, the only regions in the United States east of the Rocky Mountains showing an excess being a portion of the cotton region east of the Mississippi, southern Virginia, and portions of Arkansas, Missouri, New York, and Wisconsin. There was a deficiency in the rainfall in the States of the Ohio Valley ranging from 4 to 7 inches, and this deficiency occurred at such times as to have the most injurious effect upon growing crops, especially corn. The excess of rainfall in Missouri occurred early in the season, while August and September were unusually dry, the absence of rain reducing somewhat the yield of crops. The reverse conditions will be found in Iowa, the State immediately north, where the seasonal rainfall was deficient, but where timely rains occurred when the growing crops were most in need of moisture. The distribution of rainfall throughout the season from week to week may be found for any section by reference to the accompanying table.

The drought conditions which existed in Texas are indicated on Plate I by lines showing deficiency in seasonal rainfall ranging from 5 to 15 inches. The abundant rains which occurred over the southern plateau region were attended by a most favorable season in Arizona, and a report furnished by the director of the Arizona weather service states that the cattle ranges in that section are in the best possible condition and that the hay crop is sufficient for two years' demand. The Pacific

coast was favored with but slight departures from the normal conditions, but in the States on the North Pacific considerable grain was lost by the late rains occurring when grain was exposed in the fields. The spring wheat region of Minnesota and the Dakotas received less than the usual amount of rain, although the departures were not marked except in southern Minnesota, where the deficiency ranged from 5 to 7 inches. In the wheat region of the Dakotas the actual rainfall for the season ranged from 13½ to 18 inches. All stations in the Missouri Valley from Yankton, S. Dak., to Helena, Mont., received more than 10 inches of rain.

The drought in western Kansas and eastern Colorado, where the seasonal rainfall ranged from 6 to 9 inches, or a little more than one-half the usual amount, resulted in almost a complete loss of crops in that section.

Although the chart showing seasonal departures from the normal rainfall indicates an excess in New England and New York, this excess was due to the heavy rains that occurred in early May and late in August, and the latter rains were preceded by drought conditions during the growing season which resulted in some injury to crops.

Plate II exhibits the thermal conditions for the growing season of 1893, the shaded portion of the chart defining the regions over which an excess of seasonal temperature prevailed. The season was slightly warmer than usual over the greater portion of the cotton region, although the variation from the normal was very slight, except in Texas, where it amounted to from 1 to 2 degrees per day in the interior. In the States of the Ohio Valley and Lake region the average temperature was slightly in excess, but in all other districts the season was cooler than usual. Along the Atlantic coast the departures from the normal were very slight, but to the westward, over the Rocky Mountain districts and on the Pacific coast, the deficiency apparently increased with the longitude to the westward, and over the Pacific coast States it ranged from 2 to 4 degrees per day below the normal. The cool weather on the Pacific coast was not, however, unfavorable to the staple crops, and while some fruits were injured others were favored by the abnormally cool season.

Plates III and IV show the conditions of temperature and rainfall by weeks at selected stations so distributed as to give the approximate conditions which prevailed in the principal agricultural districts to the east of the Rocky Mountains. The data from which the diagrams were constructed may be found in the accompanying tables, containing data from the regular meteorological stations of the Weather Bureau, from which similar diagrams may be constructed which will show graphically the rainfall and temperature conditions which existed during the growing season over the entire country.

As in the previous year, the diagram illustrating the temperature and rainfall conditions at Springfield, Ill., is taken as an example. The heavy horizontal line marked 0 indicates the normal and the figures to the left indicate inches when referring to rainfall and degrees Fahrenheit when referring to temperature. The solid line indicates the weekly departure from the normal temperature, while the dotted line shows the weekly departure from the normal rainfall. From this diagram it will be seen that in the vicinity of Springfield, Ill., the early portion of spring was wet and cold, and also that heavy rains occurred in the last week of May, attended by about normal temperature, after which time it was relatively dry, there being but one week from June 1 to the close of September when the normal rainfall was exceeded.

This absence of rain resulted in a considerable reduction in the yield of the staple crops in that section, while it is probable that the heavy rains of early spring caused a reduction in the acreage.

It will be of interest to compare this diagram with that of Springfield for the previous years 1891 and 1892, tracing the rainfall and temperature conditions which attended the unusual corn crop of 1891 with those attending the reduced yields of 1892 and 1893 for that particular section. The drought conditions of 1893 in that section are clearly indicated by the diagram for that year, and the tabular statement shows that the drought region extended over the greater portion of the corn belt and thence eastward to the Atlantic States. The data contained in the table referred to show the departures from the normal of both temperature and rainfall for each week of the growing season, and will furnish a ready means of comparing the meteorological conditions attending the development of the several crops with the actual yields as published elsewhere in this report. With additional years of record these statements can not fail to give the probable effect of the weather conditions upon the staple crops considerably in advance of the time of ripening and securing the crop.

The following tables show the departures from normal temperature and rainfall from January 1 to and including April 3, 1893, and for each subsequent week ending with Monday to October 2, 1893:

TABLE VI.—*Temperature departures for the season of 1893 from the normal of many years.*

Stations.	From Jan. 1 to Apr. 3, inclusive.	For weeks ending— April— 10.	17.	24.	May— 1.	8.	15.	22.	29.	June— 5.	12.	19.	26.
New England.													
Eastport, Me	−2·7	−2	−1	−3	0	−2	+2	+2	+1	0	+1	+1	+1
Portland, Me	−3·2	−2	−1	−4	−3	−5	+3	0	−2	−2	+1	−2	−3
Boston, Mass	−2·0	0	−1	−4	−1	−5	+3	+2	0	+2	+7	−3	−5
Middle Atlantic States.													
Albany, N. Y	−4·3	−1	−3	−5	−4	−4	+4	−1	−3	+3	+4	+5	+1
New York, N. Y	−3·5	+1	−1	−4	−4	−3	+2	+1	0	+1	+5	0	+1
Philadelphia, Pa	−3·2	+5	0	−4	−3	−5	+1	0	−1	+3	+4	+1	+1
Washington, D. C	−2·8	+6	−1	−5	−1	−4	−2	−1	−1	+3	+3	0	+3
Lynchburg, Va	−3·9	+7	−3	−4	+3	−2	−4	−1	+1	+2	+1	−1	−1
Norfolk, Va	−4·0	+9	−1	0	+4	+1	−2	+1	+2	+3	+1	−1	+2
South Atlantic States.													
Charlotte, N. C	−3·3	+13	−4	−3	+6	−3	−5	−2	+2	0	−1	−3	−2
Wilmington, N. C	−2·1	+10	+1	−1	+7	0	−3	0	+2	−1	−1	−2	+1
Charleston, S. C	−1·7	+9	+3	−1	+5	+1	−3	−2	+3	−2	−2	−2	0
Augusta, Ga	−3·6	+12	+4	−4	+6	−3	−5	−4	+3	−1	−2	−3	−1
Savannah, Ga	−2·5	+9	+2	−1	+7	0	−4	−2	+3	0	−1	0	+1
Jacksonville, Fla	−1·8	+7	+5	−2	+6	+1	−2	−2	+3	0	−1	0	+2
Gulf States.													
Atlanta, Ga	−2·8	+12	−1	−7	+5	−3	−2	−3	+2	−1	−1	−2	−2
Mobile, Ala	−1·4	+7	0	−4	+4	−2	0	−3	+3	0	−2	−1	+1
Montgomery, Ala	−1·8	+10	+2	−6	+5	−2	−2	−3	+2	0	−3	−1	0
Vicksburg, Miss	−0·4	+12	0	−5	+4	−3	+1	−2	0	−1	−2	−1	+1
New Orleans, La	−0·9	+7	0	−4	+5	+1	0	−2	+3	+1	−4	−1	+3
Shreveport, La	+0·5	+12	−1	−8	0	−3	0	−2	0	−3	−3	−2	+1
Fort Smith, Ark	−1·2	+15	−1	−9	−3	−3	0	0	−4	−3	−2	0	+1
Little Rock, Ark	−2·1	+15	−2	−7	0	−4	0	0	−3	−3	−1	0	+1
Palestine, Tex	+0·9	+13	−1	−3	+1	−1	+2	−1	+2	+2	−1	−1	+2
Galveston, Tex	+0.3	+5	0	−2	0	−1	0	−1	+1	+1	−3	−2	−1
San Antonio, Tex	+0·5	+11	+1	+1	+2	0	−1	−1	+3	+2	−1	−2	+3

TABLE VI.—*Temperature departures for the season of 1893, etc.*—Continued.

Stations.	From Jan. 1 to Apr. 3, inclusive.	For weeks ending—											
		April—			May—					June—			
		10.	17.	24.	1.	8.	15.	22.	29.	5.	12.	19.	26.
Ohio Valley and Tennessee.													
Memphis, Tenn	−0·3	+16	−3	−6	+1	−2	+3	0	−3	−3	−1	+1	−1
Nashville, Tenn	−1·8	+15	−1	−7	+3	−2	+1	−3	−4	0	−1	0	−2
Chattanooga, Tenn	−2·4	+14	−1	−7	+4	−3	0	−3	0	−1	−1	−1	−2
Louisville, Ky	−3·4	+12	−3	−11	+2	−5	0	−2	−5	+2	+1	+2	−2
Indianapolis, Ind	−3·3	+11	−2	−11	−1	−6	0	−2	−6	+2	0	+2	+1
Cincinnati, Ohio	−4·4	+11	−3	−10	+1	−5	−1	−3	−6	+2	0	+2	−2
Columbus, Ohio	−2·9	+9	−2	−8	−1	−6	0	−3	−3	+4	+1	+3	0
Pittsburg, Pa	−2·8	+10	−2	−8	0	−5	0	−5	−3	+6	+1	+3	0
Lake region.													
Oswego, N. Y	−4·0	+1	−2	−6	−3	−5	+5	−3	−3	+7	0	+5	+3
Buffalo, N. Y	−2·9	+3	0	−5	−2	−4	+5	−2	−3	+6	0	+6	+4
Cleveland, Ohio	−2·4	+7	+2	−5	−2	−6	+3	−2	−4	+8	+1	+2	+5
Detroit, Mich	−5·0	+6	−1	−9	−6	−7	+2	−1	−5	+5	0	+4	+5
Alpena, Mich	−1·3	+3	+1	−4	−5	−1	+3	+2	−6	+3	+5	+8	+7
Grand Haven, Mich	−2·9	+4	−3	−7	−7	−6	0	0	−7	+4	−1	+8	+3
Milwaukee, Wis	−4·2	+6	−3	−8	−8	−6	+1	+1	−5	+2	+2	+4	+6
Chicago, Ill	−6·0	+6	−1	−9	−7	−9	+1	0	−8	+2	−1	+2	+4
Duluth, Minn	−3·1	+1	−5	−7	−7	−3	0	+1	−1	−3	+3	+8	+5
Upper Mississippi Valley.													
St. Paul, Minn	−5·8	+1	−11	−13	−13	−6	0	+1	−10	+2	+2	+9	+3
La Crosse, Wis	−4·4	+5	−5	−11	−11	−6	+1	+2	−5	+2	+4	+8	+2
Davenport, Iowa	−5·3	+8	−4	−10	−10	−9	+2	+3	−7	0	+1	+7	+2
Des Moines, Iowa	−4·0	+6	−7	−12	−13	−10	+2	+1	−8	−2	0	+5	+1
Springfield, Ill	−4·8	+9	−3	−12	−7	−7	+2	+2	−6	+1	+1	+5	+1
Cairo, Ill	−1·8	+12	−2	−7	+1	−4	+1	0	−5	−2	+1	+3	−1
St. Louis, Mo	−2·3	+11	−2	−11	−3	−5	+2	+3	−6	−1	+1	+4	−1
Missouri Valley.													
Springfield, Mo	−1·3	+11	−3	−9	−2	−5	−1	−2	−6	−4	−1	+1	−1
Kansas City, Mo	−3·1	+10	−3	−9	−9	−6	+3	+2	−8	−6	+1	+3	−1
Concordia, Kans	−1·7	+10	0	−6	−10	−6	+5	+3	−7	−3	+4	+3	+4
Omaha, Nebr	−2·3	+7	−4	−10	−14	−9	+3	+2	−6	−2	+2	+5	+2
Valentine, Nebr	−0·6	+5	−6	−7	−18	−8	+2	+4	−9	−4	+7	+7	+1
Huron, S. Dak	−1·6	+1	−9	−8	−13	−6	+3	+4	−7	+1	+5	+8	+3
Extreme Northwest.													
Moorehead, Minn	−5·3	−3	−9	−10	−11	−2	0	+3	−5	+2	+7	+11	+2
Bismarck, N. Dak	−2·6	−1	−11	−8	−10	−4	+2	0	−8	−4	+4	+6	+1
Fort Buford, N. Dak	−3·4	−3	−8	−9	−11	0	+3	0	−8	−3	+2	0	0
Rocky Mountain slope.													
Havre, Mont	−2·6	−4	−8	−10	−13	0	+5	+4	−4	−3	+1	−6	−2
Helena, Mont	−2·0	−2	−5	−8	−10	−2	+5	0	−8	−7	+2	−5	−4
Spokane, Wash	−1·2	−5	−8	−5	−4	−3	+1	−5	−4	−4	−2	−10	−6
Winnemucca, Nev	−3·7	−9	−8	−5	−6	−3	+9	−6	−7	0	+3	−3	−5
Salt Lake City, Utah	−2·2	−3	−9	−6	−13	−7	+6	−3	−11	−7	+6	0	−3
Cheyenne, Wyo	+0·4	+3	−7	−7	−13	−8	+5	+3	−9	−7	+5	+3	+1
North Platte, Nebr	+1·4	+4	−6	−7	−15	−7	+5	+2	−8	−7	+5	+4	+2
Denver, Colo	+3·0	+5	−6	−5	−12	−7	+5	+4	−9	−7	+7	+5	+2
Dodge City, Kans	+3·0	+9	−1	−4	−13	−7	+2	+3	−7	−2	+6	+1	+4
Abilene, Tex	+0·8	+16	+2	0	0	−1	−2	+4	+1	+5	0	−2	+7
Santa Fe, N. Mex	+1·8	+6	−5	−2	−4	−4	+1	0	0	0	+5	+2	+4
El Paso, Tex	+0·5	+7	−1	0	−4	−3	−4	−1	−2	0	+2	−1	+2
Tucson, Ariz	−0·2	+1	−5	−1	−7	−3	−3	−2	−3	0	+3	−1	+1
Pacific coast.													
Olympia, Wash	−2·2	−5	−7	−3	−2	−2	0	−4	−2	+1	−4	−8	−5
Portland, Oreg	−4·0	−9	−10	−5	−6	−5	−1	−8	−5	−2	−6	−9	−6
Roseburg, Oreg	−3·0	−8	−8	−2	−5	−2	+1	−7	−3	+1	−3	−6	−6
Red Bluff, Cal	−3·3	−10	−6	−2	−7	−2	+4	−11	−2	+8	−1	−2	−6
Sacramento, Cal	−3·2	−6	−4	−1	−5	−1	+3	−7	0	+5	−3	−1	−5
San Francisco, Cal	−2·5	−5	−4	−2	−5	−2	−1	−2	−3	−1	−5	−3	−5
Los Angeles, Cal	0	−7	−2	+2	−4	−2	0	−1	−2	−1	−1	0	−2
San Diego, Cal	+0·2	−3	−3	+2	−3	−1	0	0	−2	−2	−1	−2	−1

TABLE VI.—*Temperature departures for the season of 1893, etc.*—Continued.

Stations.	For weeks ending—													
	July—					August—				September—				October
	3.	10.	17.	24.	31.	7.	14.	21.	28.	4.	11.	18.	25.	2.
New England.														
Eastport, Me	−4	+2	+4	+3	−2	−1	+4	−2	+5	−1	−3	+2	0	−3
Portland, Me	−4	+1	−2	+1	+1	+1	+4	−5	+6	0	−2	0	+1	−4
Boston, Mass	−7	−1	−1	+1	+1	0	+2	−5	+6	−1	−2	0	+1	−6
Middle Atlantic States.														
Albany, N. Y	−2	−3	−1	0	0	+1	+3	−1	+6	−4	−3	−3	−1	−6
New York, N. Y	−3	+1	+1	+1	+2	0	+4	+1	+5	−2	−1	−1	+3	−7
Philadelphia, Pa	−6	−1	0	+1	+2	−1	+2	+2	+6	−4	0	−1	+5	−8
Washington, D. C	−6	0	−1	−2	+1	−1	0	0	+6	−5	+1	0	+6	−9
Lynchburg, Va	−6	+2	+1	+2	+2	−2	−2	−1	+1	−5	−1	−1	+8	−10
Norfolk, Va	−6	+1	−1	0	+1	0	+1	0	+4	−2	+2	0	+5	−8
South Atlantic States.														
Charlotte, N. C	−4	0	+2	0	+2	−2	−2	−1	−1	−3	0	+3	+8	−7
Wilmington, N. C	−3	+2	0	0	+1	−2	0	−2	+1	0	+2	+2	+7	−5
Charleston, S. C	−2	+1	0	0	+2	−2	0	−1	−1	+1	+1	+3	+8	−1
Augusta, Ga	−4	+1	0	−1	+2	−2	−2	−1	−2	−2	0	+2	+5	−3
Savannah, Ga	−2	0	−2	+1	+2	−1	0	−1	−1	+1	+1	+4	+8	0
Jacksonville, Fla	−2	+1	0	+2	+2	0	0	0	−1	0	−2	+4	+5	0
Gulf States.														
Atlanta, Ga	−1	+3	0	0	+3	−1	0	+1	+4	+1	−1	+3	+7	0
Mobile, Ala	0	+1	−1	0	+2	0	−1	+1	+2	+1	−2	+2	+3	+1
Montgomery, Ala	0	+2	0	0	+3	−1	−1	+1	+2	+2	−1	+3	+5	0
Vicksburg, Miss	−3	0	−2	−2	+1	−1	−1	−3	0	−3	−7	+3	+4	0
New Orleans, La	+2	0	−1	0	+3	−2	−1	+2	+2	+2	−3	+2	+4	+2
Shreveport, La	0	0	−2	−1	+3	−1	−1	0	−1	−5	−3	+5	+4	+2
Fort Smith, Ark	−4	−1	−2	−4	+3	−2	−2	+1	−2	−5	0	+7	+4	−1
Little Rock, Ark	−3	+1	−1	−3	+2	−1	−1	0	−2	−4	−2	+5	+5	0
Palestine, Tex	+2	0	0	0	+3	−1	−1	+1	+1	−4	−1	+8	+7	+4
Galveston, Tex	0	−1	−3	0	+1	−3	−1	0	+1	−2	0	+4	+6	+3
San Antonio, Tex	+3	+2	+2	+1	+2	+2	+2	+2	+2	−3	+5	+7	+7	+6
Ohio Valley and Tennessee.														
Memphis, Tenn	0	+1	0	−1	+4	+1	+1	+2	0	−3	−3	+4	+5	+1
Nashville, Tenn	0	+2	0	−1	+4	0	+1	0	+3	−2	+1	+4	+4	−2
Chattanooga, Tenn	−1	+2	+2	+1	+3	−1	0	0	+3	+1	−1	+3	+4	−2
Louisville, Ky	−1	+1	+3	+2	+4	+1	+1	+1	+3	−3	+6	+5	+6	−4
Indianapolis, Ind	0	+2	+3	+1	+6	+2	+1	0	+5	−3	+10	+7	+4	−3
Cincinnati, Ohio	−1	+1	+1	0	+3	0	0	0	+3	−4	+7	+4	+5	−6
Columbus, Ohio	−2	0	+1	−2	+4	−1	+1	−1	+4	−3	+7	+4	+5	−6
Pittsburg, Pa	−5	−3	+1	−2	0	−3	0	−1	+5	−6	+3	+1	+3	−9
Lake region.														
Oswego, N. Y	0	−2	−1	−2	+1	−1	+2	−2	+5	−5	−5	0	−1	−7
Buffalo, N. Y	+2	−1	+1	−1	+2	0	+2	0	+6	−4	0	+3	+1	−6
Cleveland, Ohio	−1	0	+3	−2	+4	−1	+1	0	+5	−4	+4	+4	+2	−7
Detroit, Mich	−1	−2	+3	−1	+3	0	+1	0	+5	−2	+1	+3	+1	−7
Alpena, Mich	+2	−1	+2	+1	+3	+1	0	0	+6	−1	−2	+4	+1	−4
Grand Haven, Mich	+2	−4	0	−1	+2	−1	+1	−2	+5	−5	+5	+6	+1	−5
Milwaukee, Wis	−1	−4	+4	+3	+2	+1	+1	−2	+3	−4	+1	+7	+2	−5
Chicago, Ill	−2	−1	+4	+3	+2	−1	+1	−3	+2	−4	+1	+8	0	−4
Duluth, Minn	−2	−5	−4	+2	+4	+1	+1	+1	+2	+6	+2	+6	−3	−5
Upper Mississippi Valley.														
St. Paul, Minn	+2	−2	+3	+5	+1	+2	+1	+1	0	−2	+11	+6	−2	−6
La Crosse, Wis	+2	−1	+2	+2	+2	+1	+2	+1	+3	−2	+8	+6	0	−5
Davenport, Iowa	+1	0	+2	+1	+2	+2	+2	0	+2	−2	+8	+7	0	−3
Des Moines, Iowa	−1	0	+2	0	−1	−1	−1	−2	−2	−4	+9	+7	0	−2
Springfield, Ill	0	−1	+1	+1	+2	+1	0	0	+3	−2	+8	+8	+3	0
Cairo, Ill	0	+2	0	−2	+3	+1	0	0	0	−3	+1	+5	+5	0
St. Louis, Mo	−1	+1	+1	−1	+2	0	−1	0	+1	−2	+7	+7	+4	0
Missouri Valley.														
Springfield, Mo	−3	+1	−3	−4	+3	−1	−1	−1	−1	−5	+4	+11	+5	+1
Kansas City, Mo	−2	0	−2	−3	0	−1	−1	0	−1	−5	+7	+9	+2	+1
Concordia, Kans	−3	+4	+4	−2	+1	0	0	+2	0	−3	+7	+6	+3	−2
Omaha, Nebr	−1	0	+1	−1	−1	+1	0	−1	−2	−3	+9	+8	+2	−2
Valentine, Nebr	−2	+1	+1	+4	+2	+3	−3	+2	0	+4	+11	+5	−4	−5
Huron, S. D	−1	−2	+2	+3	−3	0	−2	+3	0	+1	+13	+6	−4	−4

TABLE VI.—*Temperature departures for the season of 1893, etc.*—Continued.

Stations.	For weeks ending—													
	July—					August—				September—				October
	3.	10.	17.	24.	31.	7.	14.	21.	28.	4.	11.	18.	25.	2.
Extreme Northwest.														
Moorehead, Minn	+2	−2	+2	+5	−1	+4	−1	+1	0	+1	+12	+5	−7	−6
Bismarck, N. Dak	−3	−3	+1	+7	−3	+5	−2	+2	−1	+5	+14	+5	−8	−4
Fort Buford, N. Dak	−4	−4	−1	+8	−1	+8	−3	0	−1	+4	+13	+1	−8	−5
Rocky Mountain slope.														
Havre, Mont	−4	−2	−2	+7	0	+5	−6	+4	+1	+8	+8	−3	−10	−1
Helena, Mont	−3	−1	−2	+12	+5	+6	−5	0	+1	+7	+3	−7	−7	−6
Spokane, Wash	−4	−6	−4	+2	0	0	−7	+2	+2	+10	+2	0	−4	+2
Winnemucca, Nev	0	−3	−6	+2	+1	+3	−3	−2	+4	+5	−5	−7	−4	−4
Salt Lake City, Utah	0	−1	−3	+2	−3	0	−5	0	−2	+1	+1	−4	−3	−3
Cheyenne, Wyo	+1	+2	−2	0	−1	0	0	0	−3	+1	+6	+4	−3	−7
North Platte, Nebr	−1	−2	−1	+2	0	−1	−4	0	−2	0	+9	+6	−4	−6
Denver, Colo	+2	+2	0	0	−2	−1	+1	+2	+1	0	+5	+5	−1	−6
Dodge City, Kans	0	+3	+2	−3	+2	−3	−1	+1	0	−2	+5	+6	+4	−4
Abilene, Tex	+6	+4	+3	−1	+5	−4	+1	+4	+3	−4	+5	+12	+8	0
Santa Fe, N. Mex	+4	0	−1	−3	−1	−4	+2	−1	0	−6	+2	+1	+3	−5
El Paso, Tex	+2	−1	−2	−7	−2	−9	−1	+1	0	−6	0	+3	+4	−2
Tucson, Ariz	+2	−2	−2	−6	0	−4	−1	−3	−2	−1	−3	−1	+3	−2
Pacific coast.														
Olympia, Wash	−2	−2	−1	−3	0	−1	−2	−1	+2	+3	−1	−3	+3	−2
Portland, Oreg	−4	−5	−5	−4	0	−2	−3	−1	+2	+3	−6	−3	−2	−4
Roseburg, Oreg	−4	−3	−3	−2	0	−4	−3	−2	+3	+2	−4	−4	−3	−3
Red Bluff, Cal	+4	−4	0	+2	−1	+2	−3	−5	+2	0	−13	−6	−5	+2
Sacramento, Cal	+3	−3	+2	+2	0	+4	0	−4	+2	−3	−8	−5	−4	0
San Francisco, Cal	−3	−3	−2	−3	−5	−3	−5	−3	−3	−3	−1	−2	−4	0
Los Angeles, Cal	−1	−2	−2	+2	−2	+1	+3	−4	−3	0	−5	−5	−3	−3
San Diego, Cal	−2	−1	0	+1	−1	0	+1	0	+1	−1	−3	−5	−3	−1

TABLE VII.—*Precipitation departures for the season of 1893 from the normal of many years.*

Stations.	From Jan. 1 to Apr. 3, inclusive.	For weeks ending—							
		April—			May—				
		10.	17.	24.	1.	8.	15.	22.	29.
New England.									
Eastport, Me	−6·76	+·05	−·41	−·21	−·67	−·73	−·16	−·31	−·73
Portland, Me	−·54	+·33	+·15	+·78	−·32	+1·69	+2·43	+1·18	−·73
Boston, Mass	−·98	+·29	+·05	+·03	−·27	+2·29	−·38	+·33	−·44
Middle Atlantic States.									
Albany, N. Y	−.63	−·03	+·07	−·02	+·20	+1·84	+·09	−·19	−·06
New York, N. Y	+3·73	+.33	+1·00	+1·66	+·77	+2·93	−.60	−·07	−.49
Philadelphia, Pa	−·05	+·51	+·53	+·33	+·46	+1·12	−·63	+·01	−·25
Washington, D. C	−3·30	−·16	−·09	+·22	+·32	+2·01	−·24	+·08	−·06
Lynchburg, Va	−2·78	−·58	−·12	+·46	+·90	+2·42	−·29	−·25	+·01
Norfolk, Va	−2·65	−·97	−·89	−·77	+·85	+·52	−·11	+·18	+2·51
South Atlantic States.									
Charlotte, N. C	−3·25	−·88	+·22	−·54	−·56	+1·76	−·71	−·83	−·10
Wilmington, N. C	−4·18	−·67	−·43	−·28	−·52	+1·38	+·33	−·60	−·01
Charleston, S. C	−2·70	−·98	−·79	+·03	−·86	+·21	−·08	−·84	+·40
Augusta, Ga	−2·90	−·78	−·90	−·04	−·68	+·55	−·49	−·76	+·74
Savannah, Ga	+·18	−·98	−·12	+·50	−·72	+·18	−·36	−·27	+·20
Jacksonville, Fla	+6·53	−·70	−·57	+1·78	−·78	+·25	−·72	−·50	+1·20
Gulf States.									
Atlanta, Ga	−6·94	−·44	−·74	+·45	−·13	+·44	−·38	−·87	+1·52
Mobile, Ala	−6·87	−1·40	−·57	+1·67	+·01	+2·37	+·94	−·46	−1·07
Montgomery, Ala	−6·02	−·85	−1·09	+1·36	+·93	+2·89	−·32	−·36	−·16
Vicksburg, Miss	−6·71	−1·54	+·87	−1·42	−·07	+4·52	−·13	−1·04	+1·07
New Orleans, La	−5·01	−1·26	−·44	+1·62	−1·23	−·17	+·30	−·94	−1·28
Shreveport, La	−9·50	−1·32	+·16	−·76	−·03	+2·36	−·36	−·98	−·61
Fort Smith, Ark	−2·56	−1·17	−·40	−1·11	+5·51	+1·72	+·16	−·88	+1·68
Little Rock, Ark	−5·70	−1·12	+·54	−·63	+4·27	+1·02	−·57	−1·26	+4·41
Palestine, Tex	−7·87	−·91	−·53	−·93	+1·63	+·65	+·73	−1·48	−·79
Galveston, Tex	−7·02	−·70	−·31	+3·60	+·81	+·19	·00	−·99	−·75
San Antonio, Tex	−2·90	−·77	+·17	−·68	+·32	−·77	+2·56	−·76	−·70

TABLE VII.—*Precipitation departures for the season of 1893, etc.*—Continued.

Stations.	From Jan. 1 to Apr. 3, inclusive.	For weeks ending—							
		April—			May—				
		10.	17.	24.	1.	8.	15.	22.	29.
Ohio Valley and Tennessee.									
Memphis, Tenn	−7·95	−1·21	+1·54	−1·00	+2·50	−·32	+·52	−·85	+6·47
Nashville, Tenn	−6·76	−1·16	+1·68	−·91	+·33	−·04	+·75	−·77	+1·49
Chattanooga, Tenn	−6·35	−·59	+2·02	−·03	+·24	+3·89	−·23	−·82	+1·38
Louisville, Ky	−3·57	−·42	+1·56	+·94	+2·87	−·15	+·10	−·84	−·03
Indianapolis, Ind	+1·27	−·28	+1·67	+·66	+3·20	−·87	+·44	−·58	−·24
Cincinnati, Ohio	−1·28	+·52	+1·22	+·26	+4·48	−·69	+1·05	+·09	−·36
Columbus, Ohio	+1·35	+·03	+·46	+·11	+5·57	−·45	+·05	−·42	−·75
Pittsburg, Pa	−·74	+·42	+·58	+·48	+1·35	−·20	−·42	+1·84	−·46
Lake region.									
Oswego, N. Y	−2·74	+·25	−·31	+·55	+·66	+·80	−·23	+1·01	−·39
Buffalo, N. Y	+·74	+·49	+·45	+1·36	+·36	−·09	−·43	+2·26	−·50
Cleveland, Ohio	−·66	−·30	+·21	−·15	+1·84	−·70	+·65	+2·67	−·41
Detroit, Mich	+·36	+·44	+·27	−·05	+1·00	−·67	−·19	−·67	−·38
Alpena, Mich	−1·29	+·76	·00	+·20	+·19	−·44	+·06	−·83	+1·03
Grand Haven, Mich	+2·29	+·67	+·05	+·59	+·25	−·37	·00	−·79	+·63
Milwaukee, Wis	−·06	+1·35	+·09	+1·05	+·48	−·25	−·27	−·77	−·18
Chicago, Ill	−1·19	−·61	+·02	+·35	+1·67	−·62	−·42	−·85	+·08
Duluth, Minn	+1·25	−·09	+1·46	−·05	+·21	−·50	−·07	+·31	−·84
Upper Mississippi Valley.									
St. Paul, Minn	+1·07	−·22	+·77	+1·88	+·91	−·47	−·46	+·13	+·22
Lacrosse, Wis	+·46	−·29	+·47	+·80	+1·46	+·10	−·32	+·42	−·52
Davenport, Iowa	−·72	−·56	+1·64	+1·01	−·11	−·64	−·30	−·68	−·24
Des Moines, Iowa	−1·27	−·43	−·15	+1·85	+1·81	−·47	+·02	−·90	−·70
Springfield, Ill	−·25	+·50	+2·25	+1·90	+2·42	−·78	+·16	−·64	+3·29
Cairo, Ill	−5·20	−·38	+1·24	−·13	+3·77	+·36	+·13	−·86	+1·45
St. Louis, Mo	−·16	+·75	+1·42	+1·57	+3·73	−·45	+·16	−·92	+2·65
Missouri Valley.									
Springfield, Mo	−3·55	+·61	+·07	+·67	+2·83	+·14	+·18	−1·32	−1·35
Kansas City, Mo	−·37	−·56	+·39	+·65	+·61	+1·26	−·35	+·15	+1·36
Concordia, Kans	−2·83	−·70	−·76	−·13	−·67	−·77	+·21	−·86	−·45
Omaha, Nebr	−·64	−·68	−·08	+·98	−·03	−·21	+·66	−·09	−1·04
Valentine, Nebr	+1·31	−·41	−·31	−·13	+1·45	+·16	−·65	−·73	−·84
Huron, S. Dak	+1·25	+·13	+1·32	+·08	+·75	+·44	−·46	−·03	−·60
Extreme Northwest.									
Moorhead, Minn	+1·40	−·14	+1·35	+·65	−·16	−·39	+·14	−·45	−·60
Bismarck, N. Dak	−·01	−·46	−·18	−·50	−·31	−·55	−·51	+·21	−·54
Fort Buford, N. Dak	+·98	−·07	−·15	−·31	−·26	−·32	−·29	+4·14	−·43
Rocky Mountain slope.									
Havre, Mont	−·28	+·18	−·01	+·38	−·21	+·54	−·17	−·09	+·22
Helena, Mont	−·29	−·02	−·23	+·64	+·85	+·35	−·08	+1·30	+·08
Spokane, Wash	+·64	+1·05	+·12	+·91	+·44	+·59	−·22	+·83	−·16
Winnemucca, Nev	+·98	+·09	−·15	+·41	−·09	+·10	−·14	−·08	−·14
Salt Lake City, Utah	+·08	+·16	−·26	+·62	+·01	+·29	−·43	−·16	+·49
Cheyenne, Wyo	−·03	−·27	−·10	+·17	+·18	+·03	−·47	−·02	+·10
North Platte, Nebr	+·39	−·40	−·55	−·58	−·49	−·27	−·63	−·70	−·61
Denver, Colo	−1·02	−·42	−·06	−·17	−·46	+·85	−·74	−·07	+·49
Dodge City, Kans	−1·52	−·22	−·35	−·51	−·59	−·60	−·01	−·71	−·63
Abilene, Tex	−2·43	−·97	−1·07	−1·11	−·79	−·95	+4·68	−·98	−·91
Santa Fe, N. Mex	−·08	−·21	−·21	−·21	−·12	+·05	+·62	−·21	−·21
El Paso, Tex	−·66	−·07	−·07	−·03	−·00	−·06	+2·21	−·07	−·07
Tucson, Ariz	−·42	−·07	−·07	−·06	−·00	·00	+·71	−·05	·00
Pacific coast.									
Olympia, Wash	−·77	−·11	+·72	+2·76	−·46	+·78	−·26	+1·10	−·36
Portland, Oreg	−8·24	+·32	−·28	+·54	−·16	+·56	−·52	+·34	−·41
Roseburg, Oreg	−2·18	+1·65	−·18	−·10	−·06	+·22	−·41	+1·27	−·34
Red Bluff, Cal	+1·49	+·35	−·57	−·24	−·34	−·07	−·30	+·08	−·21
Sacramento, Cal	−1·01	+·10	−·65	−·39	−·47	+·47	−·19	+·09	−·09
San Francisco, Cal	−2·37	+·28	−·46	−·34	−·36	−·24	−·14	+·01	−·10
Los Angeles, Cal	+7·67	−·29	−·42	−·39	−·23	−·13	−·01	−·07	−·07
San Diego, Cal	+·87	+·01	−·21	−·36	−·17	−·11	+·32	−·07	−·07

TABLE VII.—*Precipitation departures for the season of 1893, etc.*—Continued.

Stations.	For week ending—								
	June—				July—				
	5.	12.	19.	26.	3.	10.	17.	24.	31.
New England.									
Eastport, Me	-·62	-·85	-·32	+·12	-·94	-·08	-·81	-·42	+·07
Portland, Me	-·77	+1·03	+·04	+·13	-·84	-·72	-·80	-·54	-·34
Boston, Mass	-·74	-·68	-·27	+.79	-·77	-·63	-·73	+·50	-·68
Middle Atlantic States.									
Albany, N. Y	-·24	+·54	-·86	-·02	-·41	-·39	-·71	-·84	-.30
New York, N. Y	-·70	+·30	-·59	+·29	-·71	-·73	-·84	-1·05	-·33
Philadelphia, Pa	-·74	-·32	-·72	+1·77	-·43	-·42	-·30	-·97	-·31
Washington, D. C	-·25	-·73	-·87	-·32	-·98	-·49	-·48	-1·03	-·82
Lynchburg, Va	-·22	-·01	+·15	+·13	+2·43	-·70	-·59	-·76	+·68
Norfolk, Va	-·59	+·65	+5·00	-·83	+3·39	-1·07	+·04	-1·30	-1·00
South Atlantic States.									
Charlotte, N. C	+·90	-·69	+·78	-·43	-·50	-·73	-1·39	+·92	-·24
Wilmington, N. C	-·99	+·49	+1·51	-·93	-1·38	-1.38	+·29	-.98	-·52
Charleston, S. C	+·41	+4·66	+7·17	-·85	-1·03	+1·23	-1·55	-·66	-1·18
Augusta, Ga	+1·26	-·42	+1·72	-·55	+1·18	-·72	-·82	+·90	-·97
Savannah, Ga	-1·40	+·66	+2·33	-·32	-·39	-·92	+1·52	-·41	-·63
Jacksonville, Fla	-·77	-·85	+·44	-·85	+·11	-·11	-1·46	-·86	+1·00
Gulf States.									
Atlanta, Ga	+1·09	+·29	-·19	-·59	-1·05	-1·05	-·26	-·40	-·36
Mobile, Ala	-·36	+2·83	-1·16	-1·42	+·04	-·31	-1·08	-·55	-1·32
Montgomery, Ala	-·38	+1·46	-·81	-1·09	-·39	-·88	-·95	+2·30	+1·23
Vicksburg, Miss	+1·82	-1·04	+·26	-·96	+·68	-·98	+·80	+·36	-·15
New Orleans, La	+1·37	-·72	-1·37	-1·61	-·17	-1.07	+·41	-·53	-·88
Shreveport, La	+5·03	-·84	+·56	-·79	-·87	-·98	-·16	-·47	-·16
Fort Smith, Ark	+·73	-1·05	+·23	-·34	+2·33	-·15	-·61	-·58	-·84
Little Rock, Ark	+4·02	-1·12	-1·02	+·34	+·22	-·79	-·17	+·90	-·82
Palestine, Tex	+2·19	-·69	+1·07	-·78	-·70	-·70	-·54	-·62	-·56
Galveston, Tex	+·14	+·98	+2·81	-1·15	-·99	-·75	+1·17	+·73	-·77
San Antonio, Tex	+·72	-·36	-·37	-·63	-·63	-·63	-·63	-·63	+·28
Ohio Valley and Tennessee.									
Memphis, Tenn	+2·46	-1·26	-·31	-·87	-·67	-·52	-·51	-·52	-·77
Nashville, Tenn	+4·39	-·94	-1·05	+·15	-·46	-·50	-·72	-·85	-·23
Chattanooga, Tenn	+2·53	+·28	-·84	+·21	-·86	-·42	-·76	-·67	-·29
Louisville, Ky	+2·12	-1·03	-1·10	+·19	-·19	-·87	-·69	-·84	+·07
Indianapolis, Ind	-·22	-1·04	-1·25	+·85	-·91	-1·12	-·94	-1·10	-·55
Cincinnati, Ohio	+1·92	-1·07	-·75	+1·02	-·09	-·30	-·15	-·63	+1·36
Columbus, Ohio	+·63	-·73	-·71	+·30	-·71	-·66	+·19	-·77	-·68
Pittsburg, Pa	+·11	-·50	-·59	+·69	-·80	-·91	+1·10	-1·00	+1·27
Lake region.									
Oswego, N. Y	-·70	+·28	-·82	+·21	-·36	-·66	-·61	-·70	-·19
Buffalo, N. Y	-·04	-·61	-·56	-·43	-·67	-·46	-·41	-·77	-·04
Cleveland, Ohio	+·74	-·87	-·98	-·70	-·71	-·37	-·34	-·85	-·71
Detroit, Mich	+2·34	+·50	-·76	-·76	-·63	+·49	+·06	-·77	-·58
Alpena, Mich	+·44	-·85	-·84	+·54	-·71	-·21	+·13	-·63	-·35
Grand Haven, Mich	+·28	+·67	-·92	-·74	-·73	+·34	+1·24	-·63	-·54
Milwaukee, Wis	+·43	+1·20	-·86	+·98	-·72	+1·39	+·41	-·74	-·46
Chicago, Ill	-·27	+·52	-·80	+·63	-·90	+·75	+·50	-·84	-·78
Duluth, Minn	-·83	-1·12	-1·17	-·18	-·70	+·81	+·74	-·59	-·83
Upper Mississippi Valley.									
St. Paul, Minn	+·05	-·99	-1·13	-·17	-·81	+·37	-·61	-·74	-·34
Lacrosse, Wis	-·85	-·93	-·32	-·20	-·56	+1.04	-·59	-1·02	-·30
Davenport, Iowa	+·89	-·29	-·54	-·44	-·53	+·70	-·85	-·84	-·70
Des Moines, Iowa	-·60	+1·24	-·97	-·40	-·94	+1·28	+·11	-·70	-·17
Springfield, Ill	+·19	-1·39	-1·13	-·30	-·91	+·33	-·37	-·37	+·05
Cairo, Ill	+6·55	-1·11	-·63	-·65	-·86	+.04	-·83	-·59	-·63
St. Louis, Mo	-·31	-·82	-·98	+·77	-·62	-·65	+·39	-·72	+·30
Missouri Valley.									
Springfield, Mo	+2·27	-1·38	-·75	+1·16	-·92	+·42	+·25	+1·70	-·80
Kansas City, Mo	+·48	-1·21	-·63	+1·54	-·68	+·46	+·45	-·74	+·68
Concordia, Kans	+2·53	-·94	-·91	+·30	+3·29	-·70	+·71	-·78	+1·12
Omaha, Nebr	+3·27	+·61	-1·39	-·64	-·53	+·01	-1·06	-·98	-·20
Valentine, Nebr	+·29	-·79	+·81	-·69	+1·58	+·24	-·58	-·70	-·52
Huron, S. Dak	-·47	-·84	-·84	-·84	-·30	+1·77	-·83	-·84	-·56

TABLE VII.—*Precipitation departures for the season of 1893, etc.*—Continued.

Stations.	For week ending— June— 5.	12.	19.	26.	July— 3.	10.	17.	24.	31.
Extreme Northwest.									
Moorhead, Minn	— ·36	— ·93	— ·36	+ ·83	+ ·19	+ ·02	+ ·61	— ·82	— ·73
Bismarck, N. Dak	+ ·48	— ·73	— ·10	— ·44	+1 ·55	+ ·05	— ·16	— ·48	— ·23
Fort Buford, N. Dak	— ·40	— ·12	— ·32	— ·62	— ·34	— ·28	+ ·98	— ·24	— ·40
Rocky Mountain slope.									
Havre, Mont	— ·14	— ·61	— ·38	— ·51	— ·43	— ·24	+ ·89	— ·42	— ·49
Helena, Mont	— ·36	— ·56	— ·23	— ·43	·00	+ ·43	— ·04	— ·21	— ·19
Spokane, Wash	— ·14	— ·29	— ·33	— ·35	— ·39	+ ·08	— ·14	— ·09	— ·07
Winnemucca, Nev	— ·21	— ·21	— ·12	— ·14	— ·11	— ·07	— ·03	+ ·08	+ ·03
Salt Lake City, Utah	— ·19	— ·21	— ·17	— ·14	— ·14	— ·14	— ·14	— ·66	+ ·35
Cheyenne, Wyo	+ ·06	— ·40	+ ·52	— ·29	— ·27	— ·41	— ·36	— ·34	+ ·13
North Platte, Nebr	+1 ·95	— ·70	— ·15	— ·77	+ ·98	— ·55	— ·43	— ·63	+ ·12
Denver, Colo	— ·24	— ·32	— ·28	— ·33	— ·38	— ·38	— ·37	—. 27	+ ·67
Dodge City, Kans	— ·72	— ·68	— ·73	— ·20	— ·48	— ·61	+ ·09	+1 ·35	— ·46
Abilene, Tex	— ·57	— ·68	+ ·13	— ·59	— ·46	— ·36	— ·35	+ ·17	— ·35
Santa Fe, N. Mex	— ·21	— ·19	— ·21	— ·23	— ·37	+ ·40	+ ·03	— ·35	+ ·28
El Paso, Tex	— ·07	— ·07	— ·07	— ·16	— ·30	+ ·57	— ·13	— ·49	— ·05
Tucson, Ariz	·00	·00	·00	— ·06	—. 49	— ·73	+. 76	+. 41	— ·71
Pacific coast.									
Olympia, Wash	— ·28	+ ·98	+ ·71	— ·32	— ·28	— ·06	+ ·17	— ·14	— ·14
Portland, Oreg	— ·43	— ·15	+ ·20	— ·40	— ·26	— ·02	— ·12	— ·14	— ·14
Roseburg, Oreg	— ·35	— ·06	— ·28	+ ·12	— ·25	— ·18	— ·06	— ·07	— ·07
Red Bluff, Cal	— ·34	— ·14	— ·14	— ·11	— ·06	·00	+ ·03	·00	·00
Sacramento, Cal	— ·07	— ·07	— ·07	— ·01	·00	·00	·00	·00	·00
San Francisco, Cal	— ·07	— ·07	— ·07	— ·04	—. 01	·00	·00	·00	·00
Los Angeles, Cal	— ·07	— ·04	— ·01	·00	·00	·00	·00	·00	—. 03
San Diego, Cal	— ·07	— ·01	·00	·00	·00	·00	·00	·00	— ·01

Stations.	For weeks ending— August— 7.	14.	21.	28.	September— 4.	11.	18.	25.	October— 2.
New England.									
Eastport, Me	— ·70	+ ·11	+ ·88	+ ·41	— ·34	— ·55	+ ·10	— ·70	+ ·09
Portland, Me	— ·57	— ·77	+ ·62	— ·30	— ·30	+ ·12	+ ·16	— ·43	— ·56
Boston, Mass	+3 ·16	—1 ·04	+ ·76	— ·74	— ·25	— ·38	— ·13	— ·46	— ·76
Middle Atlantic States.									
Albany, N. Y	+1 ·27	— ·83	— ·61	+3 ·47	— ·32	— ·21	+ ·78	— ·52	— ·27
New York, N. Y	— ·76	— ·97	+1 ·50	+2 ·80	— ·51	— ·30	+ ·20	— ·61	— ·81
Philadelphia, Pa	— ·78	—1 ·10	— ·97	+ ·31	— ·11	— ·87	+1 ·81	+ ·10	—. 65
Washington, D. C	— ·67	— ·83	— ·77	— ·64	+1 ·23	— ·34	+ ·83	—. 70	—. 52
Lynchburg, Va	+2 ·06	— ·89	— ·06	+3 ·07	+1 ·84	+ ·22	+3 ·20	— ·57	+ ·54
Norfolk, Va	+1 ·31	—1 ·36	+ ·23	—1 ·32	+ ·74	+1. 80	— ·21	— ·92	+ ·31
South Atlantic States.									
Charlotte, N. C	+ ·84	— ·68	+ ·24	+3 ·98	+2 ·46	+1 ·11	+ ·22	— ·75	+ ·42
Wilmington, N. C	+3 ·52	—1 ·60	—1 ·36	— ·99	+ ·08	— ·91	— ·26	—1 ·19	— ·78
Charleston, S. C	+3 ·56	+ ·88	— ·88	+3 ·84	+1 ·86	+2 ·46	— ·18	—1 ·39	—1 ·26
Augusta, Ga	+ ·43	— ·33	— ·76	+3 ·16	+2 ·66	+ ·24	— ·93	— ·89	— ·01
Savannah, Ga	+ ·38	+1 ·09	— ·20	+4 ·01	— ·23	+3 ·89	+ ·50	—1 ·28	—1 ·05
Jacksonville, Fla	+1 ·61	+ ·83	— ·90	+2 ·20	+ ·13	+1 ·93	—1 ·00	—1 ·89	—1 ·58
Gulf States.									
Atlanta, Ga	+ ·87	— ·11	— ·98	—1 ·05	+ ·82	+ ·58	— ·60	— ·98	— ·67
Mobile, Ala	+1 ·72	+1 ·44	—1 ·42	— ·90	—1 ·09	+8 ·20	— ·78	—1 ·07	+8 ·60
Montgomery, Ala	+1 ·83	+1 ·19	— ·04	—. 84	— ·70	+1 ·73	+ ·35	— ·71	— ·32
Vicksburg, Miss	+ ·87	— ·19	— ·09	— ·93	—1 ·02	— ·52	—1 ·00	— ·86	— ·07
New Orleans, La	+ ·74	+ ·55	—1 ·08	—1 ·40	— ·99	+2 ·18	— ·94	— ·87	+2 ·24
Shreveport, La	— ·10	+ ·18	+ ·40	— ·58	— ·82	—1 ·04	—1 ·12	— ·51	— ·77
Fort Smith, Ark	+ ·35	+1 ·50	— ·77	— ·72	— ·80	— ·47	— ·77	+2 ·93	+1 ·42
Little Rock, Ark	— ·81	— ·12	— ·71	+ ·32	— ·91	— ·27	— ·80	+ ·62	— ·25
Palestine, Tex	+1 ·75	+ ·52	— ·22	— ·61	— ·74	— ·77	— ·77	+ ·49	— ·72
Galveston, Tex	+ ·59	+ ·80	— ·58	— ·64	—1 ·61	— ·72	—1 ·83	—1 ·54	— ·63
San Antonio, Tex	— ·42	— ·52	— ·70	— ·67	—1 ·02	—1 ·11	—1 ·02	— ·81	— ·72

TABLE VII.—*Precipitation departure for the season of 1893, etc.*—Continued.

Stations.	For week ending—								
	August—				September—				October—
	7.	14.	21.	28.	4.	11.	18.	25.	2.
Ohio Valley and Tennessee.									
Memphis, Tenn	−·91	−·55	−·84	−·57	−·87	+2·84	−·79	+·94	−·68
Nashville, Tenn	+·19	−·34	−·56	−·58	−1·02	+1·93	−·18	+1·54	−·39
Chattanooga, Tenn	+1·05	+·16	−·73	−·98	−·09	+·46	−·65	−·92	−·56
Louisville, Ky	−·84	+·66	−·83	−·67	−·80	+·04	+·94	+·10	+·28
Indianapolis, Ind	−·91	−·53	−·49	−·69	−·70	−·59	+1·07	+.09	+·51
Cincinnati, Ohio	−·94	−·75	−·79	−·41	−·66	−·53	+·88	+·21	+1.64
Columbus, Ohio	−·02	−·47	−·49	−·54	−·64	−·65	−·15	−·17	−·46
Pittsburg, Pa	−·58	−·55	−·56	−·13	−1·00	−·63	−·37	+·96	−·51
Lake region.									
Oswego, N. Y	+·30	−·50	−·17	+·88	+3·25	+·16	+·09	+·30	−·60
Buffalo, N. Y	−·68	−·38	−·38	+·14	+2·97	+·18	+·01	−·20	−·84
Cleveland, Ohio	−·59	+·07	−·44	+·16	+·32	−·86	−·88	−·55	−·73
Detroit, Mich	−·70	+·12	−·04	−·27	−·63	−·63	+·29	−·31	−·37
Alpena, Mich	−·77	−·69	+·46	−·19	−·59	−·70	+1·17	+.05	−·96
Grand Haven, Mich	−·63	−·60	−·28	−·58	−·77	−·84	+·09	+·28	+·69
Milwaukee, Wis	−·70	−·42	−·08	−·43	−·63	−·68	−·65	+·05	+2·32
Chicago, Ill	−·70	−·68	−·54	−·64	−·63	−·64	−·32	+·38	+·57
Duluth, Minn	−·77	+·05	−·79	−·18	−·92	−1·02	−·91	−·86	+·23
Upper Mississippi Valley.									
St. Paul, Minn	−·84	−·21	−·73	+1·01	−·77	−·77	+·01	+·38	+·20
Lacrosse, Wis	−·81	−·43	+·01	−·77	−1.09	−1·22	−1·11	−·19	−·43
Davenport, Iowa	−·91	−·10	−·50	−·77	−·77	−·77	−·67	+·63	+1·62
Des Moines, Iowa	−·77	−·14	+·06	−·65	−·84	−·84	−·83	−·63	+·36
Springfield, Ill	−·42	−·43	−·37	−·55	−·77	−·71	−·33	+·28	−·33
Cairo, Ill	−·69	−·02	−·18	−·05	−·63	+4·09	−·30	+·20	+·94
St. Louis, Mo	−·56	−·10	−·59	−·43	−·74	−·29	−·41	+·99	+·32
Missouri Valley.									
Springfield, Mo	−1·05	−·34	−·76	−·79	−·94	−·85	−·84	+3·78	+1·12
Kansas City, Mo	−·98	−·43	−·39	−·37	−1·09	−1.10	−1·05	+·89	+·64
Concordia, Kans	−·93	−·90	−·21	+·01	−·79	−1·06	−·53	−·56	+1·57
Omaha, Nebr	−·77	+·62	+·58	−·18	−·77	−·77	−·77	−·70	+·99
Valentine, Nebr	−·45	−·07	+·66	−·28	−·25	−·28	−·34	−·35	−.11
Huron, S. Dak	−·78	−·54	−·50	−·50	−·45	−·38	−·35	−·35	−·11
Extreme Northwest.									
Moorhead, Minn	−·62	+·75	−·63	+·85	−·41	−·56	+·12	−·54	+·40
Bismarck, N. Dak	−·56	−·54	−·45	+·16	−·38	−·28	−·20	−·23	+·61
Fort Buford, N. Dak	−·35	−·27	−·09	−·17	−·24	−·21	+·24	−·17	+·78
Rocky Mountain slope.									
Havre, Mont	−·34	+·65	−·35	−·27	−·35	−·30	+·92	+·19	−·14
Helena, Mont	−·14	−·14	+·32	−·19	−·25	+·02	+·20	−·13	+1·57
Spokane, Wash	+·01	−·07	−·07	−·10	−·18	+·06	−·18	+·39	+·03
Winnemucca, Nev	·00	·00	·00	−·06	+·11	+·10	+·03	−·05	+·19
Salt Lake City, Utah	−·10	+·20	−·11	−·21	+·05	+·14	−·17	−·24	+1.02
Cheyenne, Wyo	−·04	−·28	+·22	−·28	−·20	−·26	−·21	−·15	+·19
North Platte, Nebr	−·36	−·25	+·71	+1·25	−·44	−·41	−·35	−·33	+·08
Denver, Colo	−·35	−·30	−·10	−·35	−·24	−·24	−·17	−·14	+·40
Dodge City, Kansas	−·64	−·79	+·34	−·01	−·37	−·28	−·20	−·25	+1·63
Abilene, Tex	+2·72	−·25	−·34	−·17	−·53	−·65	−·70	+1·60	−·67
Santa Fe, N. Mex	+·68	−·43	+2·10	−·14	+·07	−·38	+·21	−·18	+2·11
El Paso, Tex	+2·45	−·45	−·37	−·33	−·38	−·33	−·14	−·08	+1·46
Tucson, Ariz	+1·80	+·39	+·15	+·16	−·28	−·39	−·34	+·09	+·21
Pacific coast.									
Olympia, Wash	+·20	−·12	−·14	−·06	−·33	+1·01	−·61	−·54	−·48
Portland, Oreg	−·14	−·14	−·14	−·14	−·19	+·68	−·29	+·26	+·12
Roseburg, Oreg	−·07	−·06	−·03	−·07	−·07	+1·22	+·58	+·87	+·40
Red Bluff, Cal	·00	·00	·00	·00	−·07	+·98	−·08	−·14	−·10
Sacramento, Cal	·00	·00	·00	·00	−·03	+·15	−·07	−·07	−·09
San Francisco, Cal	−·01	·00	·00	·00	·00	+·20	−·07	−·07	−·09
Los Angeles, Cal	−·05	·00	·00	·00	·00	·00	·00	−·01	−·09
San Diego, Cal	−·07	−·07	−·01	·00	·00	·00	·00	−·02	−·07

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

SIR: I have the honor to transmit herewith my report for 1893, which contains a condensed account of the work accomplished during the year by the Bureau of Animal Industry.

Very respectfully,

D. E. SALMON,
Chief.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE YEAR.

There has been great activity during the year in the various lines of work conducted by this Bureau, and considerable modification has been made in the direction and disposition of the force in the field, which will be referred to in the enumeration of the various details which are necessary to an understanding of the subject. Notwithstanding the large force of employees and the considerable expenditures of money, the field of work which Congress has committed to the Bureau of Animal Industry has only been entered upon, and a much greater development and extension is required before the objects of the statutes are fully complied with. It will be the aim of this report to indicate the more important things which should be done in accordance with existing laws, as well as to state what has been done during the fiscal year ending June 30, 1893.

ERADICATION AND CONTROL OF CONTAGIOUS DISEASES.

The suppression and extirpation of contagious, infectious, and communicable diseases of animals, and more particularly of the contagious pleuro-pneumonia of cattle, was the most prominent object indicated by the organic act for the establishment of the Bureau. Other duties have since been added, as, for example, the inspection of live animals for export, and the inspection of meat for the interstate and export trade, but the value of these new fields of work should not lead to neglect or to a lack of appreciation of the subjects which were at first considered of paramount importance.

A number of contagious diseases still exist in the United States, which cause heavy losses to stock-owners, and which we have not yet attempted to suppress or extirpate. Tuberculosis, the most widespread of animal plagues, is attracting more and more attention each year, because of its ravages among animals and its danger to human health and life. Hog cholera is disseminated to all parts of the country by

infected cars or by hogs which have been unloaded in infected yards and have contracted the disease by such exposure. Glanders in horses is controlled in a few of our States only, and eradicated in none. All of these maladies deserve attention both because of the direct losses resulting from them and the danger to the public health which is inseparable from their existence.

CONTAGIOUS PLEURO-PNEUMONIA.

The work for the eradication of contagious pleuro-pneumonia, which has been crowned with complete success, demonstrates what may be accomplished in this direction by the National Government for the stock interests of the country. This disease, which was introduced into the United States half a century ago and allowed to spread until 11 States had been infected and the entire cattle interest had been endangered, has been completely extirpated and no case of it has been discovered since March 25, 1892.

The difficulty of ascertaining definitely that no contagion exists in a district once infected has led to the expression of doubt from some sources as to the correctness of the conclusion that the disease has been thoroughly and completely eradicated. These objections were, however, anticipated and precautions were taken which should inspire the utmost confidence. It was the policy of the Bureau to keep up the inspection and quarantine regulations in infected districts for six months after the discovery of the last case of the disease before declaring the plague eradicated, and to continue the inspection another six months before withdrawing the inspectors from the district. The inspection was, therefore, maintained in the counties of Essex and Hudson, in the State of New Jersey, and Kings and Queens counties, in the State of New York, until April 1, 1893. The period of one year after the last case of disease expired on the 25th of March, 1893, and the entire force engaged in this inspection was dismissed at the end of that month.

In addition to the work of the special inspectors engaged in the search for pleuro-pneumonia, the Bureau has another means of discovering the existence of such a disease, in the meat-inspection service, now in operation at the principal abattoirs of the United States. During the past year nearly 4,000,000 head of cattle were examined at the time of slaughter, and post-mortem examinations were made by veterinarians. Such a disease as pleuro-pneumonia could not exist among such cattle in the United States without attracting the attention of these inspectors. In not a single instance, however, have the reports shown the discovery of lesions such as indicate either the acute or chronic stage of this disease.

A private inquiry has been recently made by Dr. John W. Gadsden, a distinguished veterinarian of Philadelphia, through the members of the veterinary profession in the United States, to determine if any members of this profession had cognizance of the existence of pleuro-pneumonia. In a paper read before the International Veterinary Congress at Chicago, in October, 1893, Dr. Gadsden stated that he could obtain no trace of the disease in the United States and that he was convinced of its complete eradication.

More satisfactory evidence than this it is impossible to procure in any country, or under any conditions. The local authorities of the various sections of the country have recognized this, and have withdrawn the prohibitions placed for so long a time on cattle from districts

that were once known to be infected. The only injurious effects which remain as a legacy from the period of infection are found in the Canadian quarantine of ninety days, and the British restrictions on the landing of live cattle of American origin, which are still enforced. There are no indications of the length of time which the British Government will consider it necessary to maintain restrictions after it has been officially notified that such regulations are no longer necessary, but it is hoped that the prevailing views of the British people in favor of an unrestricted international trade will eventually lead to the withdrawal of a prohibition which is as inconsistent with existing facts as with these professions of principle.

TEXAS FEVER.

This disease, which is caused by infection disseminated by cattle not from Texas alone, but from other States adjacent to the Gulf coast and South Atlantic seaboard, is now so well understood through the investigations of this Bureau that its prevention, except in isolated cases, is easily effected. The regulations for this purpose are designed with a view of (1) defining the infected district, (2) keeping the cattle originating in this district from coming into contact with cattle from other sections of the country, and (3) disinfecting cars and pens which are likely to be used for susceptible cattle.

The knowledge of the exact limits of the infected area is still somewhat imperfect, as it can be derived only from observations of the results of shipping cattle which afterwards come into contact with susceptible animals under conditions proper for the transmission of the infectious agent. The definition of the infected district, which we already know is very nearly correct, is, therefore, experimentally changed from year to year to a slight extent, in accordance with the results of the experience of the preceding year. In this way restrictions have been removed from a considerable district which was at first supposed to be dangerous, but which is now known to be safe.

The following is the full text of the regulations for the year 1893, as issued by the then Secretary of Agriculture, Hon. J. M. Rusk, under date of February 15, 1893:

To the managers and agents of railroad and transportation companies of the United States, stockmen, and others:

In accordance with section 7 of the act of Congress approved May 29, 1884, entitled "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals," and of the act of Congress approved July 5, 1892, making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1893, you are hereby notified that a contagious and infectious disease known as splenetic or southern fever exists among cattle in the following-described area of the United States:

All that country lying east and south of a line commencing at the southwest corner of the county of Pecos, State of Texas, on the Rio Grande River; thence following the western boundary of Pecos County to the southeast corner of Reeves County; thence following the boundary line between the counties of Pecos and Reeves to the Pecos River; thence southeasterly following the said Pecos River to the northwest corner of Crockett County; thence easterly along the northern boundaries of Crockett and Schleicher counties to the southeastern corner of Irion County; thence northerly along the eastern boundary of Irion County to the northeast corner of said county; thence northerly to the southern boundary of Coke County; thence westerly to the southwestern corner of Coke County; thence northerly along the western boundary of Coke County to the southern boundary of Mitchell County; thence easterly to the southeast corner of Mitchell County, and thence northerly along the western boundaries of Noland and Fisher counties to the southern boundary of Kent County; thence easterly along the southern boundary of Kent County to the south-

western corner of Stonewall County; thence northerly along the western boundary of Stonewall County to the southeastern corner of Dickens County; thence easterly along the northern boundary of Stonewall County, to the southwestern corner of Knox County; thence northerly along the western boundaries of Knox and Hardeman counties to the Red River; thence northwesterly following the Red River to its point of intersection with the one hundredth meridian of longitude; thence northerly from said point of intersection along said one hundredth meridian to the southern boundary of the State of Kansas; thence easterly along the southern boundary of the State of Kansas to the northeast corner of the Indian Territory; thence southerly along the eastern boundary of the Indian Territory to the southwest corner of the State of Missouri; thence easterly along the southern boundary of the State of Missouri to the Mississippi River; thence running southerly along the Mississippi River to the southwestern corner of the county of Lauderdale, State of Tennessee; thence running easterly following the southern boundaries of the counties of Lauderdale, Crockett, Gibson, Carroll, Benton, Perry, Lewis, Maurey, Marshall, Bedford, Coffee, Grundy, and Sequatchie to the southwest corner of Hamilton County; thence northerly along the boundary line between the counties of Sequatchie and Hamilton to the southwest corner of Rhea County; thence easterly along the southern boundaries of the counties of Rhea, Meigs, McMinn, and Monroe, State of Tennessee, to the eastern boundary of said State; thence following the northern boundaries of the counties of Cherokee, Macon, Jackson, Transylvania, and Henderson, State of North Carolina, to the southeast corner of the county of Buncombe, of said State; thence in a northeasterly direction following the Blue Ridge Mountains to the southwestern corner of the county of Amherst, State of Virginia; thence southeasterly along the southern boundary of the county of Amherst to the western boundary of the county of Appomattox; thence northeasterly along the eastern boundaries of the counties of Amherst, Nelson, and Albemarle to the southern boundary of the county of Orange; thence along the southern boundary of the county of Orange to the boundary line of the county of Spottsylvania; thence along the eastern boundary of the county of Orange to the southern boundary of the county of Culpeper; thence easterly along the southern boundaries of the counties of Culpeper and Stafford to the boundary of King George County; thence northerly along the eastern boundary of Stafford County to the Potomac River; thence following the Potomac River southerly to the Chesapeake Bay; thence easterly along the southern boundary of the State of Maryland to the Atlantic Ocean.

From the 15th day of February to the 1st day of December, 1893, no cattle are to be transported from said area to any portion of the United States north or west of the above-described line, except by rail for immediate slaughter, and when so transported the following arrangements must be observed:

(1) When any cattle in course of transportation from said area are unloaded north or west of this line to be fed or watered, the places where said cattle are to be so fed or watered shall be set apart and no other cattle shall be admitted thereto.

(2) On unloading said cattle at their points of destination, pens shall be set apart to receive them, and no other cattle shall be admitted to said pens; and the regulations relating to the movement of Texas cattle, prescribed by the cattle sanitary officers of the State where unloaded, shall be carefully observed. The cars that have carried said stock shall be cleansed and disinfected before they are again used to transport, store, or shelter animals or merchandise.

(3) All cars carrying cattle from said area shall bear placards stating that said cars contain Southern cattle, and each of the waybills of said shipments shall have a note upon its face with a similar statement. Whenever any cattle have come from said area and shall be reshipped from any point at which they have been unloaded to other points of destination, the cars carrying said animals shall bear similar placards with like statements, and the waybills be so stamped. At whatever point these cattle are unloaded they shall be placed in separate pens, to which no other cattle shall be admitted.

(4) The cars used to transport such animals, and the pens in which they are fed and watered, and the pens set apart for their reception at points of destination, shall be disinfected in the following manner:

(*a*) Remove all litter and manure. This litter and manure may be disinfected by mixing it with lime or diluted sulphuric acid, or, if not disinfected, it may be stored where no cattle can come into contact with it until after December 1.

(*b*) Wash the cars and the feeding and watering troughs with water until clean.

(*c*) Saturate the walls and floors of the cars and fencing, troughs and shutes of the pens with a solution made by dissolving four ounces of chloride of lime to each gallon of water. Or disinfect the cars with a jet of steam under a pressure of not less than 50 pounds to the square inch.

(5) It is further expressly provided that cattle which have been at least ninety days in the counties of Coke, Nolan, Fisher, Stonewall, Haskell, Knox, and Hardeman,

State of Texas, which lie within the above-described area, may be moved from said counties by rail into the States of Colorado, Wyoming, Montana, and South Dakota, in accordance with the regulations made by said States for the admission of Southern cattle thereto: *Provided*—

(1) That cattle from said area shall go into said States only for slaughter or grazing, and shall on no account be shipped from said States into any other State or Territory of the United States before the 1st day of December, 1893.

(2) That such cattle shall not be allowed in pens or on trails or on ranges that are to be occupied or crossed by cattle going to the Eastern markets before December 1, 1893, and that these two classes of cattle shall not be allowed to come into contact.

(3) That all cars which have carried cattle from said area shall, upon unloading, at once be cleaned and disinfected in the manner provided by these regulations.

(4) That the State authorities of the States of Colorado, Wyoming, Montana, and South Dakota agree to enforce these provisions.

The losses resulting yearly to the owners of susceptible cattle, both in the interstate and export trade, by the contraction of this disease from exposure in unclean and infected cars and pens, and by means of the manure carried in unclean cars from place to place, have become a matter of grave and serious concern to the cattle industry of the United States. It is absolutely essential, therefore, that this cattle industry should be protected as far as possible by separating the dangerous cattle and by the adoption of efficient methods of disinfection.

Inspectors will be instructed to see that disinfection is properly done, and it is expected that transportation companies will promptly put into operation the above methods.

The following supplementary regulation was subsequently issued over your own signature under date March 13, 1893:

Notice is hereby given that the regulations of the Department of Agriculture, dated February 15, 1893, concerning cattle transportation, are modified so as to permit cattle that have been in the counties of Wilbarger, Baylor, Throckmorton, Shackelford, Jones, and Pecos, State of Texas, since January 1, 1893, and have not come into contact with any cattle brought into said counties from other counties in the infected district since said date, to be moved from the said counties by rail into the States of Colorado, Wyoming, Montana, North Dakota, and South Dakota, in accordance with the regulations made by said States for the admission of Southern cattle thereto: *Provided*—

(1) That a permit shall first be obtained from the Secretary of Agriculture for such movement. The application for said permit must state the name of the county in which said cattle are located, the name of the owner of said cattle, the number of cattle to be moved, and the route over which said cattle are to be transported to the above-named States.

(2) That said permit shall be forwarded to the inspector of the Department stationed at Kansas City, Mo., who will detail an officer to inspect said cattle and ascertain whether they are entitled to be shipped under the provisions of this order, and who, upon finding that the same are so entitled, will countersign said permit and supervise the movement of said cattle to the point of shipment. The said officer, before delivering such permit, shall obtain affidavits of the owner or manager of the cattle and of 2 reputable and disinterested persons showing that they are acquainted with the cattle sought to be shipped, and that they have known said cattle since the 1st day of January, 1893, and that said cattle have been kept in the territory described above and have not come into contact with any other southern cattle. These affidavits will be forwarded by him to the Department of Agriculture.

It is further ordered, that the second proviso of the fifth rule of the regulations of February 15, 1893, providing that cattle moved into the above-named States under said rule shall not be allowed in pens or on trails or on ranges that are to be occupied or crossed by cattle going to the Eastern markets before December 1, 1893, and that these two classes of cattle shall not be allowed to come into contact, is hereby rescinded.

This was followed, May 19, by a further modification as follows:

Notice is hereby given that the regulations of the U. S. Department of Agriculture, of date February 15, 1893, concerning cattle transportation, are modified so as to permit cattle that have been in the counties of Cherokee, Clay, Macon, Jackson, and Transylvania, State of North Carolina, since the 1st day of January, 1893, and have not come into contact with any cattle brought into said counties from other counties in the infected area described in said regulations since said date, to be moved from the said counties by rail into the States of Kentucky, Tennessee, and Virginia for grazing purposes, in accordance with the regulations made by said States for the admission of southern cattle thereto.

Again, August 30, the following notice was issued:

Notice is hereby given that the regulations of the U. S. Department of Agriculture, of date February 15, 1893, concerning cattle transportation, are modified, from and after September 1, 1893, so as to exclude the counties of Benton, Washington, Carroll, Madison, Boon, Newton, Marion, Searcy, Baxter, Stone, Fulton, Izard, Sharp, Independence, Lawrence, Randolph, Greene, and Clay, in the State of Arkansas, from the infected area described in said regulations, and the quarantine line established by said regulations is hereby changed so as to place these counties north of said line; provided, that nothing in this order is to be construed to interfere with the regulations of any State affecting the movement of cattle from this portion of the State of Arkansas.

The efforts of the Bureau in maintaining these regulations and in preventing the dissemination of the disease have been very successful. The large stock yards of the country have been kept free from infection, and no reports of losses of any great magnitude from the ravages of this disease have been made to the Department. There have been, however, a number of small outbreaks, due to violations of the regulations or to the necessary driving of cattle intended for slaughter from the railroads and stock yards to the abattoirs. The roads upon which such cattle are driven become infected, and native cattle allowed to travel over them frequently contract the disease. On account of the large interests involved it would not be advisable to stop the driving of southern cattle to slaughter-houses, particularly as the owners of susceptible cattle have it in their power to guard against the disease by keeping their animals upon their own premises. The animals affected are usually cows which are allowed to run at large in the suburbs of the large cities.

It is to be regretted, however, that there have been some violations of the regulations by railroad companies, which have been followed by the appearance of the disease in various States and also in several shiploads of cattle consigned to foreign ports. The effects of these violations of the regulations are very serious, not only in the direct losses of cattle caused by the disease, but in the unfavorable influence on the export trade and upon the restrictions enforced by other countries. In general, transportation companies have cheerfully and efficiently coöperated with this Bureau by giving stringent orders to their employees to comply with the regulations. In a few cases, however, there has been a disposition to evade the requirements, which, if persisted in, should be met with prosecution in the courts, or, if this fails, by legislation providing that cars for carrying infected cattle should be painted a distinctive color and used for that purpose only.

The publication of the special report of this Bureau on the nature and causation of Texas fever has led to experiments being made in various parts of the country with a view to destroying the ticks which act as bearers of the contagion, and thus rendering the southern cattle harmless. The chief difficulties have been to discover some substance or compound that could be applied to the infected cattle and which would destroy the ticks without injuring the animals or involving too much expense.

Mr. R. J. Kleberg, secretary of the Texas Live Stock Sanitary Commission, has used a mixture which he believes to be effectual and the cost of which is only about 1 cent per animal. He has also invented a dipping tank to contain the mixture into which the cattle are plunged from an automatic trap door in such a manner that they are completely submerged. He estimates that 2,000 head of cattle may be passed through one of these tanks in a day.

The importance of this invention, if experience should confirm the conclusions from the tests so far made, would certainly be very great. It may possibly lead to the disinfection of all of the cattle from the infected district, and thus do away with the separate pens now maintained at the leading stock yards, which have been the cause of more or less dissatisfaction but which have been necessary to prevent the spread of the disease. Such a change would simplify the regulations, make the prevention more nearly absolute, and would save the annoyance and loss of which shippers from the infected district now complain on account of discriminations made by buyers against cattle from the quarantine pens.

Experiments to test this method will be made during the summer of 1894 on a plan which it is hoped will give decisive results. The dipping tank appears to work very satisfactorily, and there can scarcely be a doubt as to the possibility of passing the animals through it with the necessary facility and rapidity. The only question is as to the efficiency of the mixture which is used for killing the ticks. These parasites have great powers of resistance, and in our experiments at the Bureau laboratory they have not been killed by chemical agents of various kinds, even when far too concentrated to be applied to the bodies of cattle.

MALADIE DU COÏT.

This exotic disease, which has been known in Europe since 1796, was first discovered in the United States in 1884. It was doubtless introduced with some of the horses imported for breeding purposes, and its nature not being at first recognized its dissemination occurred before attention was attracted to it. A considerable number of animals were found to be infected in Illinois, and the danger to the horse industry was such that the disease was eradicated through the efforts of the State authorities.

At that time there were rumors of the existence of the disease in other States, but if it existed elsewhere the affected animals were not located and interest in the subject soon subsided.

In 1892 this Bureau was informed of a disease affecting breeding horses in northwestern Nebraska, which had the general characters of maladie du coït. Dr. George C. Faville was detailed to make an investigation, and after examining a considerable number of animals reported that this disease existed there and that probably 200 horses were infected.

No steps were taken for the eradication of the malady until June 12, 1893, when Dr. Faville was again ordered to Nebraska with instructions from the Secretary of Agriculture to coöperate with Mr. Edward Shelden, agent of the Bureau of Animal Industry, for the purchase and destruction of all affected animals. It was found that a large number of the diseased animals discovered by the investigation of 1892 had since died, and the horse-owners of the infected section had taken precautions which had to a large extent prevented the further dissemination of the contagion. Thirty-two diseased animals were found in Nebraska and five in South Dakota. These were all purchased and killed.

The expense of eradicating this disease in the States mentioned, including the salaries and traveling expenses for the time the animals were being searched out, was as follows:

Salaries	$2, 512. 42
Traveling expenses	1, 096. 12
Cost of horses (37)	1, 624. 00
Total	5, 232. 54

This disease is incurable by any method of treatment now known, although a small proportion of the affected animals recover without treatment. The course of the malady is slow, and, although it at first appears as a local affection, it becomes generalized after a few weeks or months, and animals may live for three or four years, being capable of disseminating the contagion during all this time. It is, consequently, necessary to destroy affected animals in order to eradicate the disease. In doing this, compensation must be paid, as affected horses are in most cases capable of doing some work, and, unless they are bred, there is no danger to other animals from them. It is this chance of their being bred, either by the present or some subsequent owner, which makes it essential that they should be destroyed.

The disease is one which rapidly spreads among breeding stock, and in some cases is so mild that no symptoms can be discovered except upon the most careful examination by a veterinarian. A stallion affected in this mild form may be purchased by a person who has not the slightest idea that the animal is unsound, and the result is the infection of a large number of mares before any one in the locality suspects that the deadly contagion has been introduced.

The existence of this disease in the United States is a great menace to the horse industry. If permitted to spread over a large territory, it will be very difficult to eradicate it, and the work will require much time and a large expenditure of money. Eradication wherever it is discovered is therefore very important.

The extirpation of this disease in Nebraska removes the danger from that outbreak, but it is possible that affected animals still exist in the country, and horse-owners should be on their guard. A disease so fatal, and one which is exotic and so easily extirpated, should not be allowed to remain on our soil. But owners of diseased horses do not report its presence in their animals. On the contrary, some of them conceal it and allow their animals to communicate it to others. With such a lack of public spirit among citizens, the complete extermination of the disease may require considerable time, but if stamped out wherever found it will eventually entirely disappear.

TUBERCULOSIS.

Although tuberculosis is undoubtedly a contagious disease, and is spread from one State to another by the shipment of affected animals, this Bureau has not undertaken to control or eradicate it. The general distribution of the disease, the number and the value of the animals infected, and the large force of inspectors that would be required, have made it evident that careful deliberation should be given to the subject, as the work, when undertaken, will involve great expense.

Preliminary investigations have been undertaken for determining, more accurately than is now known, the proportion of animals affected, the best means of detecting the disease, and the most practicable measures for its prevention and eradication. Tuberculin is being made in the laboratory of the Bureau and is distributed to State authorities having jurisdiction over the diseases of animals, as a means of coöperating with them. This chemical substance, which is produced during the growth of the bacillus in suitable liquids, is of inestimable value in detecting the disease, since, when injected under the skin in proper doses, it causes the temperature to rise from 2° to 5° F., while in healthy animals no such effect is produced.

Heretofore all of the tuberculin to be obtained in this country was imported from Europe and sold at prices which greatly restricted its use. There is now great demand for it, but the facilities of the Bureau have hardly been sufficient to supply the local authorities who have been using it. Public interest in the question of limiting the prevalence of tuberculosis is rapidly increasing and one State after another is taking up the work. It is probable, therefore, that preparations must soon be made for preparing tuberculin in much larger quantities than heretofore. This will require an increase in the expenditures for the laboratory, but there certainly is no other way in which such valuable assistance and coöperation can be given to local authorities with the same expense.

Tuberculosis considered as a disease of the domesticated animals is, on account of the frequency of its occurrence and the losses which it causes, the most important of any with which we have to deal. It therefore demands attention from an economic point of view. In addition to this, however, it is one of the most frequent and fatal diseases of mankind, and may be communicated from animals to people who consume tubercular meat and milk. There is, consequently, every reason why this Bureau, which is charged with the duty of coöperating with the State authorities to prevent the spread of communicable diseases of animals from one State to another, should do what is possible to limit the spread of tuberculosis.

Investigations have been made and are being continued to determine the frequency with which the bacillus of this disease is to be found in the milk from tuberculous cows. These investigations, so far as they have gone, indicate that the danger to the public health from this source is not so great as has been supposed by some authorities. That there is some danger, however, is evident from researches which have already been made by other investigators. No doubt the presence of the bacillus in the milk depends upon whether the development of tubercles has invaded the mammary glands. The questions connected with this aspect of the subject are of such vital importance that they should be decided at an early day, and the danger may in the meantime be avoided by pasteurizing the milk before it is used.

The danger of communicating tuberculosis to man through infected meat is not so great as through infected milk. Meat is generally eaten cooked, and is as a rule raised to a sufficient temperature to destroy the vitality of the bacilli. The meat inspection now applied by this Bureau to carcasses slaughtered for the interstate and foreign trade is an additional protection of much value.

It has recently been asserted that the meat and milk of tuberculous animals contain a sufficient quantity of tuberculin to make them especially dangerous articles of food for people already affected with tuberculosis. This assertion, extremely alarming to the large number of people who are more or less affected with the disease, is based on the known fact that tuberculin is produced during the multiplication of the bacillus, and when introduced into the tissues of an affected person in sufficient quantity it causes an access of fever, which is probably accompanied by a temporary increase in the development of the germs. These facts, however, do not warrant the conclusion just mentioned, which has been drawn from them. It is extremely doubtful if tuberculin exists at any one time in the tissues or in the milk in sufficient quantity to affect the persons consuming these articles of food. It is equally doubtful if it would produce its characteristic effects when taken into the stomach of the consumer, even if it should exist in the food

to such an extent that the consumer of these articles would receive a full dose in the amount of food consumed at one time. Tuberculin, to produce its characteristic effect, must be injected hypodermically into the tissues. When it is administered by the stomach, we have good reason to believe that it is decomposed by the digestive processes, either partially or completely, and that, consequently, its ingestion is not accompanied by the danger which has been attributed to it.

There is already enough alarm felt in connection with the danger of consuming the products of tuberculous animals without unduly magnifying the results which may follow to the helpless consumer. So far from sharing the view alluded to above, the writer is of the opinion that it is perfectly safe to consume the carcasses of animals which are only slightly affected and which are in a satisfactory condition of flesh. The emaciated carcasses of tuberculous cattle should under all circumstances be condemned, as well as all carcasses in which there is any considerable development of the tubercular process. But when, as is very frequently the case with animals slaughtered on the tuberculin test, there is only an insignificant lesion in one of the lymphatic glands and the animal is fat, free from fever, and shows the general signs of good health, the quality of the meat is not affected, and it may be consumed with perfect safety. The demand for the condemnation of these carcasses is based upon sentiment, not upon reason; and it is the duty of the scientist to advise against such useless destruction of food products, the wholesomeness of which has not been impaired.

GLANDERS.

Glanders is a contagious and incurable disease of horses, more widespread than is generally supposed. It is also communicated to man from affected horses, and is then nearly always fatal in its results. This disease has been allowed to spread without adequate efforts for its control, until it can now be found in nearly every city of any considerable size and in many country districts. The greatest obstacle heretofore existing to its eradication was the difficulty of making a positive diagnosis with many suspected animals. With many affected horses the symptoms are obscure and indefinite, but the power to communicate the disease is just as marked as with those having the most apparent symptoms.

Fortunately, it has been shown by recent researches that the bacillus of glanders produces a substance during its growth in culture liquids similar to the tuberculin produced by the bacillus of tuberculosis, and that this substance, which is called mallein, may be used for the diagnosis of glanders in the same manner as tuberculin is used for the diagnosis of tuberculosis. The greatest problem connected with the control of glanders is, therefore, solved, and the question is no longer one of possibility but of expediency.

In order to assist State authorities in this work, mallein is prepared at the laboratory of the Bureau and is supplied to them without expense. Occasionally a veterinarian is detailed to conduct the test and decide doubtful cases, but the number of veterinarians available for such work on the force of the Bureau is so small that it is impossible to respond to all requests from local authorities for such assistance. It is evident that more vigorous efforts should be made to eradicate this dangerous and destructive disease. The losses from it each year must be enormous, but it is impossible to obtain any general statistics. The danger to mankind is also considerable, and every year cases are

recorded of its transmission to attendants of diseased horses or to unsuspecting persons, who have received the virus in the eye, nose, or mouth as it has been blown from the nostrils of some horse they have passed on the streets.

We know now that glanders arises from contagion only, and that it may, consequently, be stamped out, as pleuro-pneumonia has been, by the judicious application of veterinary sanitary measures. Efforts for its suppression are all the more indicated in this time of depression in the horse industry, when the losses from the malady are severely felt, and when the compensation for condemned animals would be less than under ordinary conditions.

INSPECTION OF ANIMALS IN TRANSIT.

The inspection of animals which are in course of transportation from one State into another or into foreign countries, or which have been imported from foreign countries into the United States, has been maintained. The object of this is to prevent the dissemination of the diseases of cattle which already exist in the United States, to prevent the introduction of contagious diseases with imported animals, and to enable our inspectors to certify to the healthfulness of exported animals. The number of animals, mostly horned cattle, which must be inspected for these purposes is very large, and the work is arduous and exacting.

INSPECTION OF SOUTHERN CATTLE.

During the quarantine season from February 15 to December 1, 1893, the inspectors of this Bureau inspected 64,184 carloads of cattle from the infected district. These cars contained 1,737,380 head of cattle, which were placed in the quarantine pens and kept separate from susceptible animals. Of these cattle 20,075 carloads were in transit for points beyond the first stock yards where they were examined. In all of these cases the cars and waybills were marked and the inspectors at the other cities were notified, in order that there might be a supervision of their movement until their destination was reached.

The cleaning and disinfection of the cars in which infected cattle have been shipped is performed under the supervision of the Bureau inspectors. During the season of 1893 they reported the disinfection of 56,406 cars.

In addition to the supervision of such cattle moved by rail for slaughter, there were inspected 248,230 head of cattle shipped or driven from Texas for grazing purposes. Of these, 4,182 were from the infected area, and were held in quarantine until they could be safely moved. It was also necessary to intercept and quarantine 42,500 other cattle which the owners were attempting to drive across the quarantine line in violation of the regulations.

It will be seen from this statement of the work accomplished that the prevention of Texas fever involves a service of considerable magnitude, and one that is distributed over a very large territory.

INSPECTION OF IMPORT ANIMALS.

The inspection of animals imported into the United States has been continued under the act of Congress approved August 30, 1890. On account of the official announcement by the Government of Great Britain that cattle imported into that country from Canada were found

affected with contagious pleuro-pneumonia, this Department issued an order on February 3, 1893, requiring that all cattle imported into the United States from Canada should be retained in quarantine for a period of ninety days. The total number of animals arriving from Canada inspected by this Bureau at the time of importation was 462,092. Of these, 445,507 were sheep, 577 were cattle, and 16,008 were swine. The quarantine stations established at the ports of New York, Boston, and Baltimore for the reception of animals imported from countries not on the American continent were maintained during the year under the regulations which have been enforced for a number of years. The total number of animals quarantined at these stations was 1,297, of which 77 were cattle, 1,189 were sheep, 24 were swine, and 7 were trained animals. No cases of contagious diseases were found among the imported animals during the year. Attention is again called to the fact that no legislation has been enacted which provides for the inspection of horses imported into the United States. These animals are subject to several very dangerous contagious diseases, which may, at any time, be introduced with them. Already one disease, known as "dourine," or "maladie du coït," which is not indigenous to this country, has been introduced by horses, and this Department deemed the matter of such importance that measures were taken, at considerable cost, for eradicating it.

INSPECTION OF EXPORT CATTLE.

The inspection of cattle for export has been continued during the year under the provisions of the act of Congress approved August 30, 1890. The total number of inspections made during the fiscal year ending June 30, 1893, was 611,542. This number includes reinspections at ports of export of cattle previously inspected at the interior stock yards. The total number of cattle tagged for export was 289,240. Of the total number of cattle examined 292 were rejected for various causes as not being in proper condition for shipment abroad. The exports of live cattle were about 100,000 head, or 25$\frac{3}{4}$ per cent less than the preceding year. The falling off occurred during the last half of the year, as the first two quarters showed a slight increase. This loss of trade appears to have been the result of an increase in the cost of export cattle in the American market, which amounted to from 80 cents to $1 per 100 pounds.

VESSEL INSPECTION.

The inspection of vessels has been continued in accordance with the regulations prescribed under the act of Congress approved March 3, 1891, for the safe transport and humane treatment of cattle in their voyage across the Atlantic. The total number of vessels inspected was 696, of which 282 sailed from the port of New York, 209 from Boston, 1 from Portland, 13 from Newport News, 69 from Philadelphia, 6 from Norfolk, and 116 from Baltimore. Of 294,002 head of cattle landed in Great Britain during the fiscal year the losses at sea amounted to but 1,377, being 0·47 per cent, or less than one-half of 1 per cent. The loss for 1892 was seven-eighths of 1 per cent, and for 1891 it was 1$\frac{3}{5}$ per cent. There has consequently been a continuous diminution of losses at sea as the result of the enforcement of the regulations of this Department. The regulations bearing upon this are the Texas fever regulations, which prevent the infection of export cattle with this disease; the inspection of export cattle, which prevents diseased animals from being

exported, and the vessel inspection, which secures proper ventilation, strong and properly constructed fittings for the ships, and good attendance. One of the largest exporters recently informed the writer that whereas, before the enforcement of these regulations, he had paid as high as 8 per cent on the value of the export animals for insurance, he had just made a contract with an insurance company insuring his export cattle for this year for three-fourths of 1 per cent on the value.

INSPECTION OF AMERICAN CATTLE IN GREAT BRITAIN.

This Bureau has continued the inspection of American cattle landed at the foreign animal wharves in Great Britain during the last fiscal year. The object of this inspection is to learn the condition in which our cattle arrive, the extent of the losses at sea, and to determine whether the lung disease with which some of these animals have been found affected by the British inspectors was really contagious pleuro-pneumonia as alleged. Without such an inspection we would have no means of determining the beneficial effects of the various regulations for preventing disease and losses at sea among export cattle. During the year 54 animals found among American export cattle have been reported by the British veterinarians as being affected with contagious pleuro-pneumonia. Our inspectors in Great Britain have examined the lungs which were produced as evidence of this disease, and have in each instance pronounced the diagnosis incorrect, and declared that the animals were affected with the noncontagious forms of pneumonia which arise from exposure during the voyage. The history of these animals, however, has been traced by following the records of the inspection and tagging in the various stock yards in this country, and it has been clearly shown that no contagious disease existed where the animals were fattened, or where unloaded and fed in transit.

The effect of the regulations for the inspection and supervision of export cattle has been excellent from every point of view. The exportation of diseased cattle has been prevented; the losses at sea have been reduced to a minimum; the cattle have arrived in better condition than ever before; the insurance rates have been reduced, and the traffic has been facilitated. The British restrictions preventing the shipment of American cattle inland have not yet been revoked, but the reason alleged for their enforcement has been removed, and, although the government has been very deliberate and conservative in its action concerning this matter, it is presumable that in the end the United States will obtain fair treatment for this important branch of its export trade. Until this is accomplished, it is extremely important that the inspection service, both in this country and England, should be maintained. Without the record obtained from this service, the argument in favor of admission of our cattle could not be made conclusive.

MEAT INSPECTION.

The inspection of live stock and their products under the act of Congress approved March 3, 1891, has been continued in the manner prescribed in the regulations of March 25, 1891. The total number of animals examined which have been marked for identification in the manner prescribed in this law was, for the fiscal year ending June 30, 1893, 6,854,702. Of this number 3,922,174 were beef cattle; 92,947 were calves; 870,512 were sheep, and 1,960,069 were hogs. There were 1,036,809 quarters of dressed beef tagged and exported, and 10,534,102 quarters of dressed beef tagged for the interstate trade. There were

9,096,613 packages of canned, salted, and smoked beef stamped for identification, and 38,955 packages of pork products likewise stamped. Of the cattle inspected there were found diseased on ante-mortem examination 95, and on post-mortem examination 1,584 animals were condemned. Trichinæ were found in 60,108 carcasses of swine, being $3\frac{1}{20}$ per cent of those examined. Of the animals, excluding hogs, condemned as unfit for human food, 133 were affected with actinomycosis; 583 with tuberculosis; 117 with Texas fever; 589 were badly bruised, and the remainder were otherwise affected.

IMPROVEMENT OF THE MICROSCOPIC WORK.

The experience of the Bureau in making microscopic examinations under the system first established proved that one microscopic examination of the three specimens taken from a carcass in the manner described in the regulations was not sufficient to conclusively establish the freedom of the carcass from trichinæ. The system was therefore changed on September 7, 1892, and an order was issued requiring a double examination to be made of each of the samples submitted for microscopic examination. Out of 1,172,047 carcasses examined since this order went into effect, there were found on the first examination 34,552 containing trichinæ, while on the second examination there were found 5,518 others affected in the same way. This demonstrates the necessity of a second examination in order to secure conclusive results.

COST OF INSPECTION.

The cost of the inspection of cattle, sheep, and calves for the year ending June 30, 1892, was $5\frac{1}{2}$ cents per carcass. The cost of microscopic inspection of pork was 6 cents per carcass. For the year ending June 30, 1893, the cost of the inspection of cattle, sheep, and calves was reduced to $4\frac{1}{3}$ cents per carcass, while the cost of microscopic inspection was increased by the double examination to $8\frac{3}{4}$ cents per carcass. The following tables show the cost of inspection in detail by months:

Statement showing the number of animals inspected, total cost of meat inspection and microscopical examination of pork, and average cost per head for examination during the fiscal years ended June 30, 1892 and 1893.

FISCAL YEAR ENDED JUNE 30, 1892.

Month.	Number of cattle, sheep, and calves, inspected.	Cost of inspection.	Average cost per head.	Number of hogs inspected.	Cost of inspection.	Average cost per head.
			Cents.			*Cents.*
July	186,009	$12,337.54	$6\frac{2}{3}$	9,655	$2,025.51	21
August	280,600	14,402.55	$5\frac{1}{8}$	14,650	2,236.62	$15\frac{1}{5}$
September	396,742	15,704.69	4	36,851	3,950.17	$10\frac{3}{4}$
October	463,384	16,224.24	$3\frac{1}{2}$	103,978	5,961.16	$5\frac{2}{5}$
November	334,997	18,872.60	$5\frac{2}{3}$	119,387	6,047.31	$5\frac{1}{8}$
December	308,919	14,752.72	$4\frac{3}{4}$	130,995	6,297.02	$4\frac{7}{8}$
January	325,449	19,541.96	6	118,290	6,451.60	$5\frac{1}{2}$
February	278,869	16,127.83	$5\frac{3}{4}$	126,447	7,006.23	$5\frac{1}{3}$
March	308,182	16,631.24	$5\frac{1}{3}$	113,297	7,205.37	$5\frac{1}{2}$
April	289,725	15,930.05	$5\frac{1}{3}$	141,865	7,026.61	5
May	315,906	20,887.66	$6\frac{2}{3}$	152,419	8,155.80	$5\frac{1}{3}$
June	322,767	32,996.65	$10\frac{1}{5}$	185,241	14,701.82	$7\frac{7}{8}$
Aggregate	3,811,549	214,459.73	....	1,276,075	77,065.22	....

Average cost of inspection for the year: Cattle, sheep, and calves, $5\frac{1}{2}$ cents per head; hogs, 6 cents per head.

Statement showing the number of animals inspected, total cost of meat inspection and microscopical examination of pork, and average cost per head for examination during the fiscal years ended June 30, 1892 and 1893—Continued.

FISCAL YEAR ENDED JUNE 30, 1893.

Month.	Number of cattle, sheep, and calves, inspected.	Cost of inspection.	Average cost per head.	Number of hogs inspected.	Cost of inspection.	Average cost per head.
			Cents.			*Cents.*
July	367, 655	$16, 713. 55	$4\frac{1}{2}$	164, 195	$9, 671. 83	$5\frac{7}{8}$
August	412, 756	17, 043. 61	$4\frac{1}{10}$	181, 666	11, 494. 09	$6\frac{1}{3}$
September	472, 156	16, 348. 01	$3\frac{1}{2}$	126, 017	11, 686. 02	$9\frac{1}{4}$
October	489, 672	17, 289. 29	$3\frac{1}{2}$	127, 923	12, 330. 49	$9\frac{2}{3}$
November	461, 043	21, 341. 62	$4\frac{2}{3}$	137, 446	12, 848. 76	$9\frac{1}{3}$
December	398, 390	20, 644. 23	$5\frac{1}{6}$	159, 341	17, 175. 70	$10\frac{3}{4}$
January	400, 448	20, 379. 19	$5\frac{1}{12}$	213, 307	19, 823. 92	$9\frac{1}{4}$
February	358, 117	19, 021. 27	$5\frac{1}{3}$	181, 654	17, 996. 44	$9\frac{9}{10}$
March	387, 723	21, 982. 70	$5\frac{2}{3}$	177, 187	17, 341. 78	$9\frac{4}{5}$
April	376, 842	19, 858. 04	$5\frac{1}{4}$	171, 701	14, 568. 14	$8\frac{1}{2}$
May	386, 251	17, 652. 71	$4\frac{1}{2}$	182, 734	14, 229. 04	$7\frac{3}{4}$
June	374, 580	18, 006. 15	$4\frac{7}{8}$	145, 898	13, 200. 87	9
Aggregate	4, 885, 633	226, 280. 37	....	1, 969, 069	172, 367. 08	....

Average cost of inspection for the year: Cattle, sheep, and calves, $4\frac{3}{4}$ cents per head; hogs, $8\frac{3}{4}$ cents per head.

EXPORTS OF INSPECTED PORK.

During the year ending June 30, 1892, there were exported of inspected pork 76,911 cases, containing 38,152,874 pounds. For the year ending June 30, 1893, the exports of inspected pork amounted to only 41,715 cases, containing 20,677,410 pounds. The quantity exported directly to countries requiring inspection in 1892 was 22,025,698 pounds, and in 1893, 8,059,758. There has consequently been a very heavy decrease in the amount of exports of inspected pork during the past fiscal year. It is asserted by packers and shippers that a considerable portion of the inspected pork which is shipped to Great Britain, Holland, and Belgium is reshipped to countries requiring inspection, but this Department has no means of determining the exact quantities. It should be added that the falling off in the export trade was not confined to inspected pork, but was also marked in the total quantity of pork exported to all countries. In 1892 the quantity exported was 665,490,616 pounds, while in 1893 it amounted to but 527,308,695 pounds. This decrease is, no doubt, accounted for by the high prices of pork which have prevailed in this country during the fiscal year 1893, and which affected the trade to countries requiring inspection more disastrously than the general trade, because the markets for American pork in those countries had been more recently opened and were less firmly established. The following table shows the number of pounds of inspected pork exported from the beginning of the inspection to June 30, 1893, by countries.

Statement showing the number of pounds of inspected pork products exported and examined under the act of Congress of March 3, 1891, from the first exportation of such products, September 6, 1891, to June 30, 1893.

Location.	Number of hogs examined.	Countries to which shipped.				
		Germany.	Belgium.	Holland.	Great Britain.	France.
Chicago	1,127,428	16,047,888	6,332,539	1,757,764	715,992	1,168,127
Milwaukee	360,793	2,274,124	578,232	466,043	6,176,820	139,198
Indianapolis	9,488	2,546	38,218	12,840	47,525	
Kansas City	659,018	1,138,151	941,397	479,313	167,877	223,533
South Omaha	305,245	1,450,394	936,305	682,806	55,557	18,504
Boston	313,821	5,861,833	2,221,324	2,805,037		307,283
Ottumwa	60,656	137,731			565,589	6,820
Cleveland	91,100	189,661	12,365		38,527	1,050
Buffalo	129,642	68,546			3,368,259	
East St. Louis	7,630	205,313				
Pittsburg	17,905					
Aggregate	3,082,726	27,376,187	11,060,380	6,203,803	11,136,146	1,864,515

Location.	Countries to which shipped.						Total number of pounds.
	Denmark.	Italy.	Norway and Sweden.	Spain.	British Columbia.	Switzerland.	
Chicago	312,991	76,907	203,319			11,169	26,626,696
Milwaukee	15,085		100,878				9,750,380
Indianapolis							101,129
Kansas City			2,542	4,937	7,000		2,964,750
South Omaha			25,642		12,500		3,181,708
Boston	428,325	6,609					11,630,411
Ottumwa							710,140
Cleveland							241,603
Buffalo							3,436,805
East St. Louis							205,313
Pittsburg							*268,274
Aggregate	756,401	83,516	332,381	4,937	19,500	11,169	59,117,209

* Stored in New York subject to export orders.

Statement showing exports of pork products to the countries requiring certificates of inspection, the estimated value of such products exported, and the expenses from the commencement of the work, June 22, 1891, to June 30, 1893.

Location.	Number of pounds exported to countries requiring certificate to June 30, 1893.	Estimated value on basis of 12 cents per pound.	Cost of work to June 30, 1893.
Chicago	17,605,913	$2,112,709.56	$68,709.29
Milwaukee	2,428,407	291,408.84	23,533.67
Indianapolis	2,546	305.52	5,297.08
Kansas City	1,366,621	163,994.52	43,291.80
South Omaha	1,468,898	176,267.76	26,492.08
Boston	6,604,050	792,486.00	21,959.79
Ottumwa	144,551	17,346.12	8,923.11
Cleveland	190,711	22,885.32	13,174.89
Buffalo	68,546	8,225.52	12,268.25
East St. Louis	205,313	24,637.56	1,733.93
Total	30,585,556	3,610,266.72	225,383.89
Pittsburg	No exports.		3,874.91
Nebraska City	No exports.		6,563.68
Repairs			14.50
Aggregate	30,085,556	3,610,266.72	235,836.98

Statement showing number of pounds and cases of inspected pork exported during the fiscal year ended June 30, 1893.

Countries.	Pounds.	Cases.
Germany	7,770,618	16,404
Belgium	4,107,923	7,807
Holland	1,822,067	3,501
France	271,325	522
Great Britain	6,621,351	13,248
Denmark	10,012	20
Italy	7,803	20
Norway and Sweden	25,642	50
British Columbia	19,500	125
Switzerland	11,169	18
Total	20,677,410	41,715

ADDITIONAL LEGISLATION NEEDED.

While the work of meat inspection has been found to be practicable and has been enforced without friction, the Bureau is not able, under existing laws, to properly dispose of unwholesome and condemned carcasses. An extension of the inspection, which has been made since the close of the fiscal year ending June 30, 1893, to the ante-mortem and post-mortem examination of swine, increases the number of condemned carcasses and adds to the difficulty of protecting consumers from condemned meat. The act of Congress of March 3, 1891, under which this inspection is carried on, does not definitely provide for the disposition of unwholesome or diseased carcasses. Section 5 of this act makes it unlawful for any person to transport from one State to another the carcasses of any sheep or swine, or the products thereof, which, on the inspection provided by the Department of Agriculture, had been declared by the inspector to be unsound or diseased. A penalty is provided for any violation of this section. There is nothing in the law, however, which prevents the marketing of these diseased carcasses in the State where the animals are killed. While there is no difficulty in condemning an animal that is found to be diseased or in placing a tag on the carcass, it is still possible for the owner to remove this tag and use the carcass in the local trade. It may be added that it is practically impossible for this Department to follow such diseased carcasses into the local market and prevent their being resold and shipped outside of the State. It is an unfortunate fact that there is not proper protection in the law for the consumers of meat in the State where diseased animals are killed, and that such meat may be shipped into other States without detection in the manner above indicated. To guard against this danger there should be some legislation compelling the immediate destruction of any animal or carcass found by the inspectors of this Department to be diseased and unfit for human food. In no other way can the public be properly protected against the use of this meat.

FUTURE WORK OF THE INSPECTION DIVISION.

The present duties of the inspection division indicate that the inspection of export cattle, import cattle, vessel inspection, the transportation of Southern cattle, and meat inspection may be considered as having become regular and permanent lines of work. These different branches of the service, with the exception of meat inspection, are now well organ-

ized and have a force sufficient to cover the entire field of work. The meat inspection must still be extended to many different abattoirs where it has not yet been enforced. An order of September 13, 1893, extends the meat inspection to all swine slaughtered in the United States for both the interstate and export trade. This will require an increased number of inspectors and assistants. The time has come, however, when there is no longer reason for not enforcing the act of March 3, 1891, which requires the inspection of all cattle, sheep, and swine slaughtered for the interstate trade. The value and desirability of this inspection is appreciated by both the producer and consumer, and the importance of it is even greater than is generally supposed. The aim of the Department should therefore be, in the fulfillment of the duties devolving upon it under the statutes, to extend this inspection as rapidly as possible, until all the animals which are killed for interstate or foreign commerce come under this supervision.

PUBLICATIONS.

Three important bulletins have been issued during the year—one on Texas or Southern cattle fever, which changes almost entirely prevailing views in regard to this disease; the second giving a detailed report of the experiments for the cure of actinomycosis, which demonstrates that this disease, so long believed to be incurable, may be treated with great success; a third which gives the results of investigations in relation to infections and parasitic diseases of domesticated animals. These bulletins are all extremely important. They contain investigations extending over a considerable period of time, and they are among the most valuable scientific publications which have recently been issued in any country.

Appended hereto are reports from the Division of Animal Pathology and the Biochemic Laboratory.

INVESTIGATION OF INFECTIOUS DISEASES OF DOMESTICATED ANIMALS.

By Dr. THEOBALD SMITH, *Chief of the Division of Animal Pathology.*

TUBERCULOSIS IN CATTLE.*

Considerable attention has been paid to this subject during the year by this division. In view of the widespread interest now manifested concerning this disease, it seemed best to briefly discuss here some of the means which should be resorted to in dealing with it, and to leave the detailed statement of the investigations carried on during the year for separate publication in the form of bulletins.

The subject of prevention, as applied to the bovine disease, has not thus far received the attention it merits. Comparative pathologists have exploited certain other phases largely bearing on meat inspection. Thus in Germany much discussion has taken place among prominent veterinary hygienists as to the relative fitness of the meat of tuberculous animals for human food. Much investigation of a certain kind has

*The reader is referred to the following publications on this subject in former reports of the U. S. Department of Agriculture: First Annual Report of the Bureau of Animal Industry, p. 350; Sixth and Seventh Annual Reports (1889-'90), p. 45; Report of the Secretary of Agriculture for 1889, p. 93; Special Report on Diseases of Cattle, p. 398; Bulletin No. 3 of the Bureau of Animal Industry (1893), p. 60.

been stimulated by this discussion and much of importance brought to light, yet the problem of preventing the living animal from taking the disease has not been the direct object of these researches. It should not be forgotten, however, that every new fact elicited will in some way contribute toward the checking of this now frightfully prevalent cattle disease, and that rational suggestions can have permanent value only when the natural history of this disease in all its bearings shall have been most fully illuminated. It is fortunate for veterinary prophylaxis that tuberculosis as it occurs in the human family has been made the subject of exhaustive investigations. From the results obtained we may draw freely in discussing the prevention of bovine tuberculosis, for the bacillus causing the disease in cattle and the one causing the disease in man are conceded to be identical. The recent investigations certainly do not militate against this well-established fact.

Concerning the prevention of human tuberculosis, we encounter two classes of opinions. There are those who maintain that, since tubercle bacilli are very generally disseminated, and therefore inhaled by all, the only safeguard is a thoroughly healthy body which is able to overcome these intruders. Others maintain that tubercle bacilli are not universally disseminated, and that the best means of preventing the spread of tuberculosis is to enforce thorough disinfection of the expectoration and, if possible, isolation of the patient. The exhaustive investigations of Cornet support the view that tubercle bacilli are most abundant in the immediate environment of the phthisical patient, and that they are not demonstrable in the dust of streets.

The great prevalence of bovine tuberculosis brings up questions precisely similar to those just stated. Can any check be put upon the continued increase of tuberculosis by any action on the part of individual cattle-owners, or are we to rely upon the vitality of cattle and their physical improvement to destroy the bacilli introduced into the body in one way and another? The problem pertaining to human tuberculosis is not of money value. With cattle it largely is. To keep them in the best surroundings may cost more than to neglect them, and it may appear cheaper to allow an animal to succumb occasionally to tuberculosis or to slaughter an infected one than to keep stables clean, dry, sunny, and well ventilated, to provide suitable pasture in the warmer seasons, and to remove and destroy all animals which show the slightest signs of emaciation. The problem of making the laws of physiology and hygiene harmonize with the financial outcome in the raising of animals must be left to each individual owner, so long as no harm springs therefrom to the public. In bovine tuberculosis, however, there may be much harm done to human health by the utilization of milk containing the bacilli of tuberculosis and by the sale of meat from cattle in an advanced stage of the disease. The control of this disease should not be left to the interested dairyman and cattle dealer, but should become a subject of surveillance by those who are appointed to watch over the public health.

In the following pages the measures suggested for the restriction of tuberculosis are those which each cattle-owner may and should make use of. They are primarily written for the instruction of the public, for in the prevention or the eradication of such a contagious disease as tuberculosis, it is the action of the individual owner which will finally decide whether the disease will continue to flourish or be suppressed. The intelligent persistent application of a few simple rules by a large number of persons is much more effective with such an insidious and

widely prevalent disease than any sweeping measures in which they can take only a subordinate part and by which the root of evil is not attacked.

THE WAYS IN WHICH TUBERCLE BACILLI ARE DISCHARGED FROM THE BODY OF TUBERCULOUS CATTLE.

Tubercle bacilli may be discharged from any tuberculous focus which stands in communication with the exterior of the body. In the earlier stages of the disease, when only the lymph glands may be diseased, no discharge of bacilli can take place. Subsequently, however, in tuberculosis of the lungs, bowels, uterus, and udder this may take place at any time.

The lungs, according to all observers, are most frequently diseased. The rapid caseation and softening of small and large masses of lung tissue lead to the coughing up of yellowish opaque masses containing more or less mucus. In most cases of lung disease, even when quite restricted, were found tubercles and tuberculous ulcers of the bronchi and trachea which were in all probability due to secondary infection from the diseased lungs.* In advanced pulmonary disease the entire mucous membrane of the trachea is frequently covered with patches of tubercles.

Both the presence of tuberculous disease of the air tubes and the frequent finding in them of caseous masses are evidences of the frequent upward discharge of infectious matter. It is claimed by some veterinarians that such matter is ejected with some force during coughing.

The mucous membrane of the intestines does not become affected until somewhat late in the course of the disease. In only one animal out of 60 recently examined, and this the most advanced case of all, was the mucous membrane diseased. In such a case the passage of tubercle bacilli from the ulcerated mucosa can not be called in question, and the manure thus becomes a disseminator of the virus. This, to be sure, may be occasionally infected before intestinal lesions become recognizable. When the lungs are affected the expectorated masses may be swallowed and then discharged through the bowels.

When tuberculosis has attacked the generative organs tubercle bacilli may pass out through the vagina. Animals thus affected may become in more than one sense dangerous. The tubercle bacilli may not only be discharged indiscriminately, but during copulation the genital organs of the bull may become infected, and the virus thus transmitted to other cows by the bull. Fortunately, primary disease of the generative organs of the female seems to be rare. In the many cases of incipient tuberculosis examined by the writer these organs were free in all cases. In those cows in which more or less extensive disease of these organs was observed the infection appeared to have proceeded in every case from the peritoneum. In other words, when the uterus becomes tuberculous the disease is usually pretty far advanced and evidenced by other symptoms.

When the udder is affected the milk contains tubercle bacilli. These become disseminated by spilt milk in the stables; but worse than this, they are taken into the body of infants and children. Such milk is furthermore dangerous in that it is liable to infect calves at a very early age, and thus lay the foundations of a disease which may become a focus of infection for young and old in the herd before death finally carries off the victim.

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* In no case was tuberculosis of the air tubes found without disease of the lung tissue.

CHANNELS OF INFECTION.

Having thus briefly sketched the different ways in which tubercle bacilli may leave the body of diseased cattle, it is next in order to trace the ways in which they enter the system.

The transmission of tubercle bacilli from diseased to healthy cattle may be both direct and indirect. In the preceding pages allusion has been made to the infection of calves with milk from tuberculous cows and to infection of bulls from cows and *vice versa* during copulation. The virus may also be transmitted when animals lick one another on the mouth and nose. The most common mode of infection is evidently indirect—through the air. How this is brought about has been quite thoroughly cleared up by investigation of recent years, more especially by those of Cornet. The tubercle bacilli, discharged in caseous masses from the lungs during coughing, from the intestines in the manure, from the vagina in secretions, and from the udder in the milk, become dried with the adherent substances and are carried as dust into the air, to be drawn into the lungs during inspiration. Tubercle bacilli are not carried in the air unless thoroughly dried, according to the well-known determination of Nägeli that bacteria are not given off from moist surfaces. It is claimed by some that cattle may discharge masses from the air passages with considerable force, and that such masses may be inhaled by cattle standing directly opposite. That tubercle bacilli may be transferred in this way is not to be denied, but moist masses can not be drawn into the air passages, and it is more probable that the glands of the throat (retropharyngeal) may become infected in this way. Again, it is not probable that tubercle bacilli are discharged from caseous foci without being imbedded in more or less of the broken-down tissue and in mucus from the air passages. Such moist masses can not possibly float or be drawn into the lungs. The most frequent infection must, therefore, be attributed to the inhalation of thoroughly dry bacilli. They are sucked in through the trachea and main bronchi and lodge most frequently in the large caudal lobes.

The second most important channel of infection is the digestive tract. The introduction of tubercle bacilli by way of the mouth is indicated by disease of the submaxillary, parotid, and retropharyngeal glands and by infection of the mesenteric and portal glands. The sources of the virus which enters the mouth are all discharges which soil the food of the animals. The cheesy particles coughed up from the lungs form probably the major part of the infectious material, although in far advanced cases with ulceration of the intestines the bowel discharges must carry off many tubercle bacilli. The gastric juice, according to some recent feeding experiments of Cadéac and Bournay,* seems to have little or no destructive effect on tubercle bacilli. The excrement of dogs fed with tuberculous tissues still contained bacilli capable of producing the disease after inoculation. The infectious matter may thus be taken up with the food both on pastures and in stables. A further means of infection by way of the digestive tract already mentioned is through the milk of tuberculous cows.

The infection of the udder may take place in two ways—from the exterior and by way of the blood. The latter mode would take place chiefly in advanced stages, when the disease had become generalized by the discharge of some focus into the blood stream. Though the disease of the udder may not be visible or palpable, it is not less danger-

* Compt. rend. Soc. de Biologie, 1893, p. 599.

ous. External infection may take place through the hands of the milker carrying the virus from an infected udder. How frequent this mode of infection is we have no means of knowing. The writer has seen about three cases of present or past infection of the udder in a hundred cases.

A case of udder infection is reported in Bulletin No. 3 of the Bureau of Animal Industry (on p. 62). Though the udder appeared normal to the unaided eye, the udder lymph glands (pubic) showed tuberculous deposits. Subsequent microscopic examination showed miliary tubercles in liver and kidneys. Guinea pigs inoculated with some of the milk became tuberculous.

Inoculation during copulation, when either male or female genital organs are diseased, is easily comprehended. It is not difficult to understand that a healthy male may infect a healthy female soon after having come into contact with a diseased female.

Tuberculosis in calves at birth is very rare. The disease is usually acquired in the uterus by the passage of tubercle bacilli from the mother to the fœtus in the blood. The notion, at one time quite prevalent, that tuberculosis was largely inherited must be given up; for statistics show that the number of infected animals increases with age, and post-mortem examinations do not bear out the inheritance theory as a means of explaining the wide prevalence of bovine tuberculosis. We do not hereby deny the inheritance of a more or less susceptible disposition to contract the disease on exposure, or the actual infection of the fœtus in rare cases.

RELATIVE FREQUENCY OF INFECTION THROUGH THE LUNGS AND THE DIGESTIVE TRACT.

From a purely practical point of view it is of the highest importance to determine, as precisely as possible, the predominating channels of infection. We have seen in the preceding pages that the tubercle bacilli enter the body in two ways mainly—through the lungs and through the digestive tract. Hence, disease of the lungs and lymph glands of the thorax are an indication of air infection, while disease of the glands of the head and throat, of the mesenteric glands and of the liver are indications of food infection.* Which of these modes predominates? Authorities are pretty well agreed that, judging from the location of the disease, the lungs are most frequently affected primarily. In one herd of 60 animals, all of which were slaughtered and carefully examined, 47 out of 53 diseased animals had been infected through the air. Some of these had also been infected through the food, but the air infection was evidently independent of the food infection, whereas the food infection (in some cases) may have been secondary to the air infection in the same animal, and caused by swallowing the matter coughed up from diseased lungs. The following table summarizes the condition of this herd. The sign + indicates disease of the organ or structure at the head of the column:

* There are exceptions to this rule which space forbids us to discuss here. It may be mentioned that cattle with tuberculosis of the lungs may swallow the expectoration, and thereby infect the digestive tract secondarily.

TABLE I.—*Distribution of tuberculous lesions in the body of infected cattle.*

Number.	Age.	Infection probably through food.*: Retro-pharyngeal glands.	Other glands of head.	Mesenteric glands.	Portal glands.	Liver.	Peritoneum.	Uterus.	Infection through the air.: Lungs.	Bronchial glands.	Posterior mediastinal glands.	Pleura.	Glands of muscles.	Pubic or udder glands (milk probably infected at some time).	Remarks.
301	4									+	+				
302	5								+ and bronchi.	+	+				
303	5			+	+				+	+	+			+	Infection probably generalized.
304	5														
305	5														
306	6			+					+	+	+				
307	4				+						+				
308	2									+					
309	2	+													
310	1½									+	+				
311	7			+					+	+					
312	6								+	+	+				
313	6									+					Traumatic pneumonia.
314	6			+	+				+ and bronchi.	+	+	+			
315	6	+	Parotid glands; tonsils.												
316	6									+	+				
317	3									+					
318	1			+	+				+	+	+				
319	1									+					
320	2½														
321	3														
322	1										+				
323	2½									+	+				
324	3				+	+			+	+	+				
328	4										+				
329	3	+													
330	12									+					
331	6								+						
332	7									+					
333	5			+	+	+									

* In these tables no attempt is made to separate those cases in which the infection of the digestive tract may have been secondary to disease of the lungs. Hence the percentage of food infection here indicated may be much higher than is actually the case.

TABLE I.—*Distribution of tuberculous lesions in the body of infected cattle*—Continued.

Number.	Age.	Infection probably through food.*					Peritoneum.	Uterus.	Infection through the air.				Glands of muscles.	Pubic or udder glands (milk probably infected at some time).	Remarks.
		Retropharyngeal glands.	Other glands of head.	Mesenteric glands.	Portal glands.	Liver.			Lungs.	Bronchial glands.	Posterior mediastinal glands.	Pleura.			
334	3									+	+				
335	5				+					+	+				
336	8			+					+		+				
337	12	+		+					+	+	+				
338	3	+	(?)	+	+	(?)	+	(?)	+	+	+	+			
339	7			+					+	+	+				
340	9														
341	9								+	+	+				
342	9									+	+				
343	6	+					+		+	+	+				
344	6	+													
345	9									+	+				
346	9			+						+	+				
347	2									+	+				
348	8			+						+	+				
349	4									+	+				
350	6									+	+				
351	2				+				+	+	+				
352	3	+													
353	4														
354	9								+	+	+				
355	5			+						+	+				
356	9								+ and trachea		+				
357	8														
358	6			+						+	+				
359	7								+	+	+				
360	9										+				
361	8										+				
362	11			+					+	+	+				
363	9	+									+				

* In these tables no attempt is made to separate those cases in which the infection of the digestive tract may have been secondary to disease of the lungs. Hence the percentage of food infection here indicated may be much higher than is actually the case

TABLE II.—*Distribution of tuberculous lesions in the body of infected cattle.*

Number.	Age.	Infection probably through the food.					Peritoneum.	Uterus.	Infection probably through the air.				Glands of muscles.	Pubic glands, (milk infected at some time).	Remarks.
		Retropharyngeal glands.	Other glands of head.	Mesenteric glands.	Portal glands.	Liver.			Lungs.	Bronchial glands.	Posterior mediastinal glands.	Pleura.			
586	5								+	+	+				
587	15		Submaxillary	++	+				+	+	+	++	Right prescapular, right axillary.		
590	11	++	do	++	+		+++				++	+++			
591	8	++		+					++		+				
592	4	++							+++	+	+	+			
593	4	++		+						+	+				
594	5								+	+					
595	4	++		+	+	+	+		+++	++	++	++		+	Renal glands.
597	4			+	+	+			++	++	++				
598	4	++							+	+	+				
599	4			+	+					+					
600	3		Submaxillary	+						+	+				
601	4			++	++				+	+	+				
602	3	+	Parotid	+	++				+	+	+				
606	2									+	+	+			
609	4	++		+		+			+		+				
610	4			+	+	+			++	+	+				
611	4	++	Left parotid and submaxillary.								+				
614	2								+	+	+				
615	2								+		+				
616	2	++													
617	1			+	+						+				
619	3	+								+	+				
620	2					+			+		+				
621	2	++							+	+					
622	1		Submaxillary	+		+									
623	2								++	+	+				
625	1	+		+	+	++			+		+				
626	1			+							+				
630	1			+					+						
631	1	++		++							+				
633	2	++									+				
634	$\frac{2}{3}$													+	Bull calf.
635	2	++							+	+	+				

Through the kindness of the secretary of the State Board of Health of New York the writer was recently enabled to examine the major portion of a herd of grade Devons killed for the State by Dr. Cooper Curtice, State cattle inspector. This herd had been tested by Dr. Curtice with tuberculin and found extensively diseased. Appended is a table including those diseased animals which were examined with Dr. Curtice. Those examined by him alone presented, according to his statement, practically the same variety of changes found in those tabulated on page 147.

This table shows that the infection of the throat and mesenteric glands and of the liver was almost as frequent as that of the lungs and associated glands. Here evidently infection of the food played a very important rôle, and the question arises whether the tubercle bacilli came through the milk or through the food soiled by infectious matter thrown off from the lungs of diseased cattle. This it would be difficult to determine. The most acceptable inference is that it came through the milk. The milk of this herd was used to manufacture butter, and the calves received the skimmed milk. It follows, therefore, that they would receive more milk than in those herds from which the milk was sold entire. If we bear in mind that according to Scheurlen* tubercle bacilli tend to settle to the bottom rather than to rise with the cream, both when the cream is allowed to rise on standing and when it is collected by centrifugalizing, the young stock in this and similar herds must receive the greater number of tubercle bacilli likely to be present. It follows furthermore that if there is one cow in the herd giving milk containing tubercle bacilli these are fed equally to all the animals, and all become affected alike. According to Bollinger, however, there would be a certain safeguard in mixing the milk, for the number of tubercle bacilli received by each calf would be very small, and when below a certain number infection would not take place. This may be true under certain circumstances, but it should also be borne in mind that the quantity of milk consumed by calves under such circumstances is considerable.†

The probability that the milk was the source of the extensive infection in this herd is strengthened by the fact communicated to me by Dr. Curtice, that the owner had lost cattle for many years back and not less than five in the preceding year. There must have been some advanced cases of disease in the herd at that time through the milk of which the yearlings had become infected.

Circumstances will, therefore, influence more or less the manner of the infection. In some herds it may come largely through the milk to the younger animals, in others through the air of the stables in which the dried tubercle bacilli are kept afloat by currents of air. On the whole a double infection both through the air and through the food seems to be common, one or the other predominating according to local conditions. In the New York herd above tabulated the food infection appeared to be more intense than the air infection and the changes induced by the former more advanced. In the herd examined in the District of Columbia the contrary is true. It should be noted here that while the average age of the animals in the latter herd was $5\frac{1}{2}$ years, it was only $3\frac{1}{2}$ in the former.

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* See Bulletin No. 3, p. 64.

† According to observations of my own, a very small number of tubercle bacilli *will* produce disease in guinea pigs, but the disease is very slow in its progress and likely to be overlooked if the guinea pigs are killed before the end of the second or third month.

If we take into consideration the intensity of the disease process it would seem that infection of the lungs is acquired later than food infection where animals are exposed to both. Food infection is direct, while air infection is more subject to chance and more diluted in proportion to the fresh air animals are allowed to obtain.

PREVENTIVE MEASURES.

The preceding pages point clearly to certain measures which must be carried out thoroughly in order to obtain and maintain a herd free from tuberculosis. These measures are in brief as follows:

(1) Destruction of all animals which show a high (fever) temperature after the injection of tuberculin. Where the tuberculin test can not be made, all unthrifty animals, all that cough or have enlarged glands in any part of the body, should be at once removed and destroyed, and this weeding out should be practiced promptly whenever the symptoms above mentioned appear. No consideration should induce any person to delay the destruction of suspected animals. Whenever the history of a herd points to the existence of tuberculosis for many years such herds should be slaughtered entire.

The importance of this weeding out of tuberculous animals can not be overestimated. It is equivalent to removing the bacilli of this disease from the surroundings of those animals still unaffected. The tubercle bacilli can not multiply outside of the body. They simply live a latent existence for a number of months, and unless some accident carries them into the body of other cattle they will perish. They differ in this respect very much from the spores of anthrax bacilli, which live for years in the soil, and under favorable conditions may germinate and multiply. The tuberculous animal is thus the only manufacturer of tubercle bacilli, and with its removal the infection declines and dies out, perhaps entirely, after four to six months. In this connection it should not be overlooked that the safety of any herd demands that persons suffering from tuberculosis (phthisis, consumption) should be permitted among cattle only on the condition that all sputum or expectoration be thrown into a receptacle and subsequently mixed with some disinfectant or boiled. The identity of the disease in man and animals being accepted, this rule needs no discussion.

(2) Even when the disease has been weeded out according to the suggestions made above, all means of facilitating the transfer of bacteria from one animal to another should still be guarded against, *because the tuberculin test is not entirely infallible.* The stock-owner should act as if tuberculosis might be present without his knowledge. Hence, cattle should not be placed so that their heads are close together; each animal should have plenty of room and occupy the same place in the stable at all times. These precautions will prevent the nasal discharges of one animal from striking the head or soiling the feed of another. It is true that it is impossible to prevent animals licking each other or pasturing in close succession over the same gound when outside of the stable, but with the worst cases and many incipient cases removed the danger from contact of one animal with another is very much reduced.

To repress, as much as possible, the dissemination of tubercle bacilli by currents of air, dust should be avoided and bedding which causes much dust should not be used. Furthermore abundant ventilation of stables should be provided. Good air has the effect of diluting infected air and thereby reducing the chances of inhaling dried bacilli. It likewise improves the vigor of the confined animal and

hence increases the body's resistance. Still better is the open air which should be granted to cattle as much as possible even during the colder season of the year. The open air greatly dilutes any discharged virus and the vicissitudes of heat and cold, moisture and dryness, and sunlight soon succeed in destroying the vitality of tubercle bacilli.

(3) To restrict the dissemination of the disease among young stock, the safest plan is to bring skimmed milk and other dairy products to the boiling point before feeding them. If the cows are positively known to be healthy this may be unnecessary, but where any doubt exists, the heating should be resorted to. Such a precaution will furthermore reduce scouring among calves, which is probably due in a great measure to bacteria in the food.

(4) Disinfection of stables should be thorough after the removal of diseased animals. This may be accomplished in various ways; either the stables may be left unoccupied for a period of six months or longer, if possible, so that the bacilli may be destroyed in the meantime by drying, wetting and drying, sunlight, and other natural agencies, or disinfectants may be freely used. Since tubercle bacilli are more resistant than the majority of disease germs now known, the strength of the disinfectant solution must not be less than as given below. The following substances may be used:

(*a*) Corrosive sublimate (mercuric chloride), one ounce in about 8 gallons of water (one-tenth per cent). The water should be kept in wooden tubs or barrels and the sublimate added to it. The whole must be allowed to stand for twenty-four hours so as to give the sublimate an opportunity to become entirely dissolved. Since this solution is poisonous it should be kept covered up and well guarded. It may be applied with a broom or mop and used freely in all parts of the stable. Since it loses its virtue in proportion to the amount of dirt present, all manure and other dirt should be first removed and the stables well cleansed before applying the disinfectant. After it has been applied the stable should be kept vacant as long as possible. Before the animals are allowed to return it is best to flush those parts which the animals may reach with their tongues, to remove any remaining poison.

(*b*) Chloride of lime, 5 ounces to a gallon of water (4 per cent). This should be applied in the same way.

(*c*) The following disinfectant is very serviceable. It is not poisonous but quite corrosive, and care should be taken to protect the eyes and hands from accidental splashing.

Crude carbolic acid	one-half gallon.
Crude sulphuric acid	one-half gallon.

These two substances should be mixed in tubs or glass vessels. The sulphuric acid is very slowly added to the carbolic acid. During the mixing a large amount of heat is developed. The disinfecting power of the mixture is heightened if the amount of heat is kept down by placing the tub or glass demijohn containing the carbolic acid in cold water while the sulphuric acid is being added. The resulting mixture is added to water in the ratio of 1 to 20. The gallon of mixed acids will thus furnish 20 gallons of a strongly disinfectant solution having an opaque milky appearance. This solution may be objectionable in so far as the milk may become tainted with the odor of carbolic acid.

(*d*) Whitewash is not in itself of sufficient strength to destroy tubercle bacilli, but by imprisoning and incrusting them on the walls of stables they are made harmless until destroyed by prolonged drying. Whitewashing should be preceded by thorough cleansing.

Particular attention should be paid to the sides and ceiling of stables. All dust and cobwebs should be periodically washed down. Those parts coming into contact with the heads of cattle—stanchions, halters, troughs, etc.—should be frequently cleansed, and disinfected when they have been used by diseased cattle.

Disinfection is at bottom a cleansing process, and whatever contributes to the cleanliness of a stable is in fact so much disinfection. The prompt removal of manure, the proper drainage of the floors of stables, sufficient ventilation and light, all contribute towards the elimination or destruction of the infectious agent.

In the open air the bacilli of tuberculosis are much more quickly destroyed than in protected places. Disinfection is, of course, out of the question on pastures. It has already been stated that persons suffering with tuberculosis should not be allowed to expectorate where cattle are grazing. In fact this rule should be upheld with reference to all places about a farm frequented by animals.

It may be argued that if, after all precautions have been taken, tuberculosis may still lurk in a herd, preventive measures are in the end useless and of no avail. This gloomy view of the situation is uncalled for, for several reasons:

The tuberculin test will weed out all severe and most, if not all, mild cases. If any remain they are in all probability mild, stationary, or partially healed cases with merely gland affections not discharging tubercle bacilli.

Tuberculosis differs from many other infectious diseases since the quantity of the virus and the frequency with which it is introduced into the body determine the severity and the rapidity of the disease process. Thus an animal continually exposed to a large quantity of tubercular virus is much more likely to become diseased than one exposed only occasionally to dried bacilli in the air. Hence the reduction of the quantity of virus discharged, even if it be not wholly eliminated, will greatly aid in keeping down the disease. In the second place, the general care which animals receive will in all probability by an increased vigor of the body resist the invasion of tubercle bacilli. When these enter the body only very rarely and in small numbers, the vigorous animals may resist the multiplication of such minimum doses of virus, and no disease will appear, or else a trifling affection may be speedily followed by cure. The writer has not infrequently found in animals traces of former disease entirely healed. Evidences of several distinct infections of different ages in the same gland have also been observed. There is thus encouragement enough for those who will faithfully carry out the suggestions given above, and who will at the same time pay attention to the general laws of hygiene governing animal life.

Bearing on these considerations comes the important one concerning the relative resistance of different breeds to tuberculosis. Much of the current information on this subject will need revision. It is evident that to compare the relative susceptibility of cattle of different breeds they should be in the same surroundings and exposed to the same relative quantity of virus for the same length of time. Thus in some herds the individual animals may be exposed to a much larger quantity of virus and for a much longer period of time than in others. Again, the surroundings of some herds may be so unhealthful, so debilitating, as to greatly reduce the natural resistance of the organs and tissues to this disease. In the investigations of this division the writer has proposed to himself the question whether the relative susceptibility of breeds can not be gauged by a careful study of the characters of this

disease, as observed at the autopsy. The solution of this question will require a large amount of material laboriously gathered during a considerable period of time. The results, however, it is believed, will fully repay the labor. At present the material collected is not of sufficient volume to permit any generalizations.

The bearing of tuberculosis on the public health demands careful municipal, State, and national control of this disease, especially in case of dairies supplying the public with milk, butter, and cheese. The sale of the milk of tuberculous cows should be forbidden as directly inimical to human health. The fitness of beef as food shou d in every case be settled by an inspector appointed by the city, State, or nation, and not left to the decision of those financially interested. For this purpose a set of regulations carefully drawn up should govern the decision of the inspector so as to leave as little margin as possible for the personal bias of this public servant to influence his judgment. Doubtful cases may now and then arise for which the inspector may find no adequate rulings and which must be decided according to his best judgment. The proper technical training of such officers becomes thus a subject of considerable importance.

Another phase of this question which should not be overlooked is the relative danger of the air of cow stables to human beings. If more than one-half of all tuberculous cattle are infected through the air, why is not the air of stables equally dangerous to human beings frequenting them? It would certainly be of interest for public-health officers to look into this matter more closely. Probably the relatively short stay of persons in stables, combined with the outdoor life usually led by dairymen, tends to neutralize the effect of such infected air.

TEXAS CATTLE FEVER.

During the year a bulletin of 300 pages, covering the work done since 1889, was published as Bulletin No. 1 of the Bureau of Animal Industry. This bulletin contains a detailed account of the nature of the disease, of the blood parasite which causes it, and of the cattle tick as the transmitting agency. It includes in an appendix a full history of all the animals under investigation in the progress of the work.

In the course of these investigations certain important possibilities were shadowed forth concerning the application of preventive inoculation to animals destined for the permanently infected area. These possibilities have been investigated during the year and some of the work reported in Bulletin No. 3 of the Bureau of Animal Industry. The major part of the work carried on during the summer at the veterinary experiment station by Dr. F. L. Kilborne and Dr. E. C. Schroeder is not yet completed.

The method of preventive inoculation experimented with is based upon the following facts, elucidated in the investigations of this disease:*

When cattle have successfully passed through an acute attack they, as a rule, are protected from future fatal attacks. They are not, however, completely insusceptible, for they may, after exposure, pass through one or more mild attacks in the following seasons.

To induce an acute attack which will not prove fatal we have found that injection of the blood of southern cattle (or of vaccinated natives) under the skin the best means. When properly cared for during the inoculation disease, death will not ensue even with very susceptible old

*Bulletin No. 1, p. 130; Bulletin No. 3, p. 67.

cows. The reason for the infectious nature of the blood of southern and vaccinated native cattle is the persistence in the blood of the microparasite of this disease. In some respects it is unfortunate that this parasite can not be cultivated, but it is always at hand and within reach in the blood of southern cattle or of those once inoculated. The experiments of the past summer consisted in making some animals partially immune by this method. These animals should now be exposed in the enzoötic territory to determine how far the method will prove successful when put into practical operation.

There are a number of details still requiring elaboration, such as the best time in the year for such inoculation, its effect on the different breeds, and its relative efficiency with regard to the age of cattle. Such experiments, naturally costly, can be more successfully carried out at State experiment stations.

The important relation of the tick to the dissemination of Texas fever has led to experiments with destructive agents. These have been carried out by Dr. F. L. Kilborne. They are not yet completed, but as far as they have gone they indicate that heat, in the form of hot water or steam, is likely to prove the only efficient means of disinfecting cars and the contained litter. Experiments looking to the destruction of ticks on Southern cattle are also being made. Were it not for these parasitic pests there need be no check on the free movement of cattle northward at any time of the year. The removal of these parasites from cattle promises to be a very knotty problem for solution owing to the tough, leathery cuticle of the former. It should also be borne in mind that any removal of ticks must be thorough, for the escape of a single tick is likely to lead, through its numerous progeny, to the infection of entire pastures. Conducting experiments of this kind requires a considerable outlay of money. If undertaken by the Department they would be most easily carried on within the permanently infected territory in connection with the experiment station of some southern State.

BRONCHO-PNEUMONIA AND INTERSTITIAL PNEUMONIA IN CATTLE.

During the year the investigation of the pathological changes observed in sporadic bovine pneumonia has been continued, and the results will soon be ready to be put into the form of a report or bulletin. The importance of this subject need not be insisted on when we bear in mind how much many cases of interlobular pneumonia resemble contagious pleuro-pneumonia. In differentiating these forms we should not rely on naked-eye inspection alone, but should bring to bear all the available resources of microscopical and bacteriological methods. The results of such investigation can not be given in a few words, but must be considered in connection with the record of all the facts upon which they are based.

SWINE DISEASES.

The study of swine diseases has been prosecuted whenever opportunity was afforded to visit places of outbreaks and observe the disease in its environment. There is, however, much work yet to be done in this field. The examination of diseased swine in different parts of the country shows that there must be causes at work besides the bacteria of hog cholera and swine plague, which we have dealt with fully in former reports. The post-mortem conditions vary considerably from case to case, and it is often impossible to range the disease under either of the bacterial diseases mentioned above. The cause of much disease in swine is very

probably due to surrounding conditions, reënforced on the one hand by bacteria, on the other by parasites. There may also supervene toxic conditions resulting from the food. It is, therefore, highly desirable that the study of swine diseases be taken up from a broader standpoint than that of infectious diseases, since infection is favored by unhygienic conditions of all kinds. While we must acknowledge the existence of more or less antagonism between hygienic laws and pecuniary profit, it is nevertheless our duty to point out the results that must follow the transgression of natural laws.

CORNSTALK DISEASE.

This disease has been under observation by Drs. V. A. Moore and F. L. Kilborne since the fall of 1892. Twelve localities were visited where outbreaks occurred. Nothing definite has resulted from these investigations in incriminating any particular organism or any recognizable condition of the food as the cause. The published assertions of others on a certain microörganism and a certain condition of the cornstalks as responsible have not been confirmed. It is to be hoped that this disease may receive further attention, if only to correct any prevalent misconception as to its nature.

RABIES IN CATTLE.

In connection with the preceding investigation, the same gentlemen came upon an outbreak of disease among cattle in Iowa which proved to be rabies, or hydrophobia. The result was the more surprising since the owner had no information that a rabid dog had caused the fatality. Since this disease is said to be quite prevalent in that part of the country, but is not recognized as rabies, some further study is greatly to be desired. There seems to be, moreover, a tendency to confuse this malady with the genuine cornstalk disease, and on this account additional information is needed.

MISCELLANEOUS INVESTIGATIONS.

During the year much material has been received from correspondents and examined with reference to the questions put. In many instances the material was sent in such a way as to be spoilt when it arrived, and hence satisfactory information could not be given. In other instances the desired knowledge could not be imparted because the information offered in the letters was very meager or else not trustworthy.

A number of minor investigations have also been carried on, either because the results were necessary in the solution of more important problems or else because it was thought that light would be thrown on important subjects by such investigations. Some of these have been published during the year in Bulletin No. 3, the contents of which are as follows:

Observations on the morphology, biology, and pathogenic properties of 28 streptococci found in the investigations of animal diseases. By Veranus A. Moore.

A nonmotile pathogenic bacillus, closely resembling the bacillus of hog cholera, found in the lungs and spleen of a pig. By Veranus A. Moore.

Pathogenic and toxicogenic bacteria in the upper air passages of domesticated animals. By Veranus A. Moore.

An outbreak of abortion in mares. By F. L. Kilborne

THE USE OF BACTERIA HAVING PATHOGENIC PROPERTIES IN THE DESTRUCTION OF SMALL ANIMALS INJURIOUS TO AGRICULTURE.

The employment of animal and vegetable parasites for the destruction of higher organisms known to be detrimental to agriculture is a method which has been suggested and tried in various departments of economic agriculture, especially for the destruction of noxious insects. Its success or failure in one branch of agricultural work does not of necessity imply a similar fate in other branches. The method is one not infrequently employed by nature in ridding herself of an overproduction of any one species, and, provided all the intricate conditions are known which nature employs in bringing the particular parasite up to a pathogenic level which enables it to act as a wholesale destroyer of its host, there is no *a priori* reason why the process of nature should not be successful in the hands of man.

But the relations of parasite to host, of disease germs to the outbreak, have been shown, in recent years, to be very complicated, so that it is not the comparatively simple bringing together of certain bacteria with certain animals which is sufficient to call forth an extensive plague. The subtle modification which may take place in the animals to be destroyed, owing to changes in their environment as well as variation in the physiological characters of the parasite, are of paramount importance in deciding the result. If we place clearly before us these limiting conditions under which experiments designed to produce plagues artificially are carried on, we shall not be over sanguine as to the outcome and be prepared for failures at any moment.

That phase of the subject which concerns us chiefly, and which is within the scope of the work done by this division, is the use of pathogenic bacteria in the destruction of the small field pests. Dr. C. Hart Merriam, Ornithologist and Mammalogist of the Department, has offered his valuable assistance in its prosecution, and has furnished the following statement as to the ground which might be covered by this kind of work:

In compliance with your request, I submit the following brief statement respecting the small mammals which are most troublesome to the farmer in the United States, and which may be fit subjects for experimental inoculation, in the hope of discovering some germ of practical use in exterminating them, or at least in greatly reducing their numbers.

The mammals that are most harmful, from the standpoint of the agriculturist, belong to 4 widely different groups or families, namely, the ground squirrels, or spermophiles (family *Sciuridæ*); the field mice, or voles (family *Muridæ*); the pocket gophers (family *Geomyidæ*), and the rabbits (family *Leporidæ*).

The ground squirrels, or spermophiles, inhabit most parts of the United States from the eastern edge of the prairies in Indiana and Illinois westward to the Pacific; and no less than 30 species are now known from the United States. They are among the most destructive of our native mammals, particularly in grain-growing districts, causing an annual loss of hundreds of thousands of dollars. Vast sums have been spent by the different States and Territories in bounties on their scalps and in poison for their destruction, but thus far without material results.

The voles, or meadow mice, may be said to occur everywhere that grass grows, and are particularly abundant in meadow lands. During ordinary years the losses they occasion are not great, though they constantly levy a moderate tithe on the products of the soil; but every now and then they increase inordinately until they overrun the land, devasting the green herbage, destroying tubers, and gnawing the bark from the young trees. Such inroads are known as *vole plagues*, of which a number have been recorded in Europe and America.

The pocket gophers occupy the western two-thirds of the United States, from the eastern edge of the prairies to the Pacific, and occur also in the southern part of the Gulf States. They live wholly underground, throwing up ridges of earth and little mounds like the moles, and feed chiefly on the roots of plants. They are very destructive in many ways, devouring tubers and eating off the roots of fruit trees. In the far West, particularly in California, the annual loss from their depredations is estimated in hundreds of thousands of dollars, and is second only to that caused by the ground squirrels. In fact, it is doubtful which is the greater pest.

The rabbits, as you know, are represented in all parts of our country and by numerous species, the number in the United States alone being greater than in any other part of the world. Except in unusual years or under abnormal conditions they are not particularly destructive in the Eastern States, but in the West they do great damage. I need only call your attention to the fact that in the San Joaquin Valley in California they multiply to such an extent that the inhabitants combine and drive them into large inclosures, where they are killed by thousands. In this way it is not uncommon to destroy from 5,000 to 7,000 on a single drive.

In view of the enormous annual losses occasioned by these four groups of mammals, it certainly seems worthy of this Department to spare no pains in the attempt to devise means for the destruction of the injurious species, and I know of no place in America where experiments in inoculation are likely to be carried on so thoroughly as in your own laboratory.

The work which thus far has been done in this field is not very extensive. It was begun by Pasteur in suggesting some years ago the use of the microbe of fowl cholera in starting epizoötics among the rabbits of Australia. The suggestion did not prove fruitful, however. While rabbits are very susceptible to this microbe* on subcutaneous inoculation, feeding seems to be harmless in most cases. The organism is, moreover, speedily destroyed by drying. It thus lacks two very important characters—infectiousness by way of the alimentary tract and a certain degree of hardiness, which lack easily accounts for its failure in practice. More recent experiments with another group of bacteria have again revived interest in this subject.

In October of 1890 Prof. Loeffler discovered an extensive epizootic among white mice kept in a cage for experimental purposes. From October 7 to November 7, 31 out of 45 mice died. The cause of this outbreak was a bacillus named by Loeffler *B. typhi murium*. The interest of the writer was at once aroused by Loeffler's publication, inasmuch as the description made this organism seem closely related to the hog-cholera bacillus. A letter to him, containing a request for a culture of this bacillus, remained unanswered. Some time after a culture was obtained from Král's collection in Prague, which enabled the writer to study the bacillus in comparison with the hog-cholera bacillus. These observations have made it certain that *B. typhi murium* belongs to the group of hog-cholera bacilli, and that its virulence is much weaker than that of *B. choleræ suis* as most frequently encountered in outbreaks of this swine disease.

The appearance of a spontaneous disease among mice led Loeffler to consider its application on a large scale in the destruction of field mice. He experimented with it on *Arvicola arvalis* and found that subcutaneous inoculation of small doses of the culture proved fatal in a few days.

*This organism belongs to the group of bacteria brought together by Hüppe under the name *Septicæmia hæmorrhagica*. One member of this group and its relation to the other members has been pretty exhaustively described in the bulletin of this Bureau on the cause and prevention of swine plague (1891).

Furthermore, field mice which gnawed at the dead bodies of these inoculated mice died in eight to twelve days of the same affection. An extensive series of experiments with the same species led to the same results. A few individuals of another mouse (*Mus agrarius*) and of the common rat (*Mus decumanus*), tested in the same way, showed themselves refractory.

In March of 1892 an extensive plague of field mice was reported from Greece,* and Loeffler was invited by the Government of that country to try his method on a large scale in the grain fields of Thessaly. On his arrival in Greece he found that the field mice differed slightly from the European *Arvicola arvalis*, and that they were even more susceptible to *B. typhi murium* than the variety he had been experimenting with in Germany. The plan of campaign which he had laid out beforehand, and which he carried out successfully, was briefly as follows:

Large quantities of culture fluid were prepared by making decoctions of oat and barley straw, to which 1 per cent peptone and one-half per cent grape sugar were added. Numerous agar tubes were also inoculated. With this stock the infection was distributed by the use of small pieces of bread soaked in the culture fluid and in suspensions of the bacteria in water prepared from the agar cultures. This bread was placed in the openings of the burrows. At the same time a number of field mice were inoculated and set free, in order that they might distribute the disease. It was Loeffler's hope that after the infection of a certain number with the bread others would become infected from the dung of the sick and by gnawing the bodies of the dead.

A few days after these preparations had been made it was reported that the bread had disappeared from the openings of the burrows, and a week later sick mice were seen in the fields. Loeffler had not looked for any decisive results until about four weeks after the infection. On his return home numerous messages announced to him the success of his method.

Since then only partial successes have been announced by some, while Loeffler† himself reports, in the main, success wherever the method has been properly applied.

According to a recent British Parliamentary report,‡ the success of Loeffler's bacillus in Thessaly was regarded as very satisfactory by some of the Greek authorities and only partially so by others. The conclusions reached by the committee are as follows:

> * * * Nor have they been able to come to any conclusion favorable to the adoption of Prof. Loeffler's method of destroying voles by means of bread saturated in a preparation of the bacillus typhi murium or mouse typhus. The personal investigation made by the chairman and secretary in Thessaly (where in May, 1892, Prof. Loeffler was employed at the expense of the Greek Government to combat the plague of field voles then prevailing in that country) convinced them that the favorable reports circulated as to the complete success of the experiments have not been justified by the results. In certain parts of Thessaly the voles were reported by landowners and others to be as numerous in January, 1893, as ever they were.
>
> Your committee readily admit that, when used in a fresh state, the bacilliferous fluid is an effective, though somewhat dilatory, poison for mice or voles, and has this advantage over mineral poisons that, as has been proved, it is innocuous to human and other forms of life.
>
> It has also been reported by Prof. Loeffler that the Scottish voles sent to him alive

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*Loeffler. Die Feldmausplage in Thessalien und die erfolgreiche Bekämpfung mittels des Bacillus typhi murium. Centralblatt f. Bakteriologie, XII (1892), s. 1.

†Centralblatt f. Bakteriologie, XIII (1893), s. 647.

‡Report of the departmental committee appointed by the Board of Agriculture to inquire into a plague of field mice in Scotland. London, 1893. Also, The Annals of Scottish Natural History, 1893, p. 129.

by instructions from your committee have been found as susceptible of the mouse typhus bacillus as their Greek congeners. But there are three objections which, in the opinion of your committee, render this method almost worthless, except for employment in houses, gardens, inclosed fields, or other limited areas:

(1) It is very expensive. The virus supplied to the Greek Government was paid for at the rate of 4*s*. a tube, containing enough, when dissolved, to treat about 2 imperial acres—a cost which in many instances would exceed the rent of the Scottish hill pasture. To this must be added the price of bread used in distributing the virus, which would appreciably raise the cost of the process. Thus to deal effectually with a hill farm of, say, 6,000 acres would entail an expenditure of from £700 to £1,000, making the remedy more costly than the evil.

(2) Mouse typhus is not contagious; it can only be communicated to those animals that will swallow some of the virus. The allegation that healthy voles will become infected by devouring the bodies of the dead has not been satisfactorily proved. That Greek voles when in captivity have been observed to feed upon the corpses of their fellows hardly warrants the assumption that Scottish voles in a state of liberty will do the same; and unless the disease were communicable from one animal to the other, it is not easy to see how the remedy could prove effective on extensive hill pastures.

(3) The fluid loses its value in about eight days after preparation. Consequently much disappointment might ensue if, after a supply had been obtained, a fall of snow or wet weather were to interfere with its distribution over the land.

The foregoing objections urged against the use of Loeffler's method are considered in a general way farther on. Here we may properly clear up certain apparent difficulties raised by the committee bearing directly on Loeffler's germ. The cost per tube given by the committee at $1 seems exorbitant. The cost of materials for each culture tube, including the tube, can hardly exceed 10 cents, if we exclude cost of plant and salaries of employees. In case of a Government laboratory these already exist, and the cost per tube would probably not exceed the estimate above given. In short, the cost can not enter into consideration, as it is trifling in comparison with the benefits derived, if the method is at all successful. The committee also state that the fluid loses its value in eight days. This can hardly be correct for *B. typhi murium*, as it is quite a hardy organism. A better estimate would be two or three weeks.

Another bacillus has been found recently, which perhaps may prove equally efficient.* This one has been fed successfully to field mice (*Arvicola arvalis* Pall.) and to house mice (*Mus musculus* L.). *Mus agrarius* Pall. remained unaffected. The writer has had no opportunity to study this bacillus. The description given makes it probable that it is closely related to Loeffler's bacillus and a member of the hog-cholera group.

Quite recently experiments were made at the bacteriological station of Odessa, Russia, with another organism (*Vibrio Metschnikowi*), on spermophiles, which are a great field pest in southern Russia.† The experiments were made on a limited number of spermophiles in cages. The animals succumbed in two or three days both to subcutaneous inoculation with culture fluid and to feeding with grain moistened with the same. In one experiment the cages proved infectious after infected spermophiles had died and been removed. In some of the experiments the infection was evidently transmitted to those animals which had gnawed at the dead bodies of their comrades. The author wisely states that from these experiments it would be difficult to predict its success on a large scale in the grain field.

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* Hugo Laser. Ein neuer für Versuchsthiere pathogener Bacillus aus der Gruppe der Frettchen-Schweineseuche. Centralblatt f. Bakteriologie, XI (1892), s. 184; XIII (1893), s. 643.

† W. Palmirsky. De l'emploi du Vibrio Metschnikowi pour la destruction des spermophiles. Archives des sciences biologiques, II, p. 497.

POSSIBILITIES AND LIMITATIONS OF THE METHOD.

The most successful application of this method demands a virus which, after the primary distribution by man, is rapidly disseminated by the animals to be destroyed, and which leads to a widespread epizoötic. Can this be attained? There are certain diseases of animals and of man which spread with great rapidity (smallpox, foot-and-mouth disease, etc.), but of these diseases the nature of the virus is still unknown. It seems that, with the possible exception of "la grippe" and Asiatic cholera, the more rapidly a disease is transmitted or the more certain and easy the infection the more elusive and difficult of recognition the virus. Hence we must content ourselves with the use of those known bacteria whose transmission is slower and which require direct feeding or perhaps a wound of the skin for infection. This is true of the bacteria thus far suggested as destroyers of animals. They depend on infection of the food mainly and on mutilation of the dead body by gnawing, etc. If animals fail to do the latter, the only other means of dissemination left is the dung or excrement of the sick, and, unless the animals are very gregarious, infection under these circumstances is not likely to be prompt. Such virus, furthermore, must be somewhat hardy and live in the soil at least several weeks.

The method is furthermore circumscribed by the fact that a certain bacterium will, in all probability, fail to be efficient with reference to more than a single genus or species. The marked difference in the degree of susceptibility to pathogenic bacteria of closely related species has been not infrequently the subject of comment in the course of bacteriological research. Hence for each bacterium it would be necessary, first of all, to test in the laboratory all those species which are to be infected in the field. Thus Loeffler tested *Arvicola arvalis*, *A. agrestis* (Scotland), *A. Güntheri* (Thessaly), *Mus agrarius*, and *Mus decumanus*. The first three were markedly susceptible, the others not at all. Our own species would require the same thorough test in order to determine accurately the degree of susceptibility.

Another difficulty to be contended with is the uncertainty as to the permanence of the virulence of any given bacterium. If, as has been so frequently demonstrated by the Pasteur school of bacteriologists, the virulence of a given bacterium may be heightened by passage through some animals and reduced by passage through others, the ulterior effect of the virus in nature can be determined only after some experience. There may also be a gradual loss in pathogenic power, which all bacteria undergo under artificial cultivation, unless special devices are resorted to to counteract it. The culture of *B. typhimurium*, with which the writer has been experimenting, seems to have undergone attenuation. Loeffler reported successful infection of house mice after the feeding and inoculation of cultures. The feeding failed to affect house mice here. How far this reduction in virulence will affect its success in field experiments remains to be seen. An attempt is now under way to restore the lost virulence.

The most important aspect of this subject is the behavior of any microbe used for distribution over fields and pastures towards the larger domesticated animals—fowls, cattle, sheep, and swine. This phase was carefully taken into consideration by Loeffler, who pronounced his bacillus innocuous after testing a variety of domesticated animals. During the work in Thessaly several persons ate of the bread steeped in culture media without experiencing any ill effects afterwards. This

circumscribed pathogenic power, which is called for in the use of pathogenic bacteria for wide distribution over the soil, makes the problem a very difficult one. A bacterium just virulent enough to kill mice may soon lose that virulence, while one more virulent, more likely to prove successful in exterminating small animals under most circumstances, will, in all probability, be dangerous to larger animals as well.

It has already been said that *B. typhi murium* belongs to the group of hog-cholera bacilli, and may be classified as a weakly pathogenic variety of *B. choleræ suis*. We do not mean to imply by this statement that the former is convertible into the latter, for there is no proof to support such a supposition. Still, this close relationship should not be lost sight of wherever the culture is used, and any increase in infectious diseases among domesticated animals should be carefully watched for. Our knowledge as to the possible increase in virulence of pathogenic bacteria in nature is as yet too limited to enable us to predict that an increase in virulence will not take place.

In the application of *B. typhi murium* to infested fields the safest plan would be to restrict its use for the present to regions to which swine can not have access. Investigations made thus far in the study of the hog-cholera bacillus and its attenuated varieties do not warrant us to state that it is dangerous to animals other than swine, and yet the discovery of a variety of the hog-cholera bacillus in the vagina of a mare immediately after abortion* indicates that any assumption as to the exclusive susceptibility of swine to this group of bacilli may prove to be only the outcome of insufficient investigation. In this connection it may be of importance to suggest to those interested in this subject to make observations concerning the relative distribution of swine diseases and field pests. Thus the virulent hog-cholera bacillus is regularly fatal when fed to gray house mice and rabbits. It is fatal to guinea pigs after subcutaneous inoculation. It is highly probable that it is fatal to many of the field pests. Is there any indication of this probability in those States where swine diseases are almost always present in mild or severe form? The presence of swine diseases presupposes the presence of pathogenic bacteria, among them the hog-cholera bacillus. The absence of field pests where their prevalence would be predicated on general grounds might furnish some suggestions more valuable than the results of laboratory experiments.

The successful prosecution of this subject finally demands a careful study of all epizoötics among the smaller wild animals which arise spontaneously. By such study it may be possible to obtain certain bacteria peculiarly fitted for the destruction of field pests, and to gain at the same time important data for the elucidation of some of the many problems connected with diseases of the larger domestic animals. Such outbreaks are best studied by specialists on the ground; but this being often out of the question, the prompt shipping of sick or dead animals to the laboratory, the latter kept as cold as possible on the journey, would greatly promote the progress of this work.

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*Bulletin No. 3 of the Bureau of Animal Industry, p. 53.

WORK CONDUCTED IN THE BIOCHEMIC LABORATORY.

By E. A. de Schweinitz, Ph. D.

TUBERCULIN TESTS.

In accordance with the line of work indicated in the report for 1892, large quantites of tuberculin and mallein for use in testing tuberculous cattle and glandered horses have been prepared in this laboratory, and either used by the Bureau or distributed to the different States.

Several tuberculous herds have been tested with the Bureau tuberculin in the District of Columbia, as well as herds in New York and New Jersey, and the results have been satisfactory. The injections, temperature records, and autopsies were made by Dr. Smith and his assistants, and the records of these will be found in connection with his report.

A discussion of the value of tuberculin is not necessary here, as this has been too thoroughly demonstrated by experiments to need defense. As indicated in the report of the Secretary, with certain national legislation and State coöperation tuberculosis in cattle can be brought under control and perhaps eventually exterminated.

Some of the States have already entered upon an active crusade against tuberculosis, and the Bureau has recently arranged to send to the board of health of New York enough tuberculin for injecting 400 cattle per month. Considerable quantities of this have also been sent to the boards of health of Minnesota and Pennsylvania and other States.

The tuberculin of this Bureau is thoroughly tested upon animals before being sent out for use. Its manufacture is carefully conducted, a glycerine beef broth having been mainly used so far for the culture fluid, which, however, will probably shortly be replaced by the use of a peptonized artificial salt culture.

The careful use of tuberculin upon man has demonstrated that it has, when administered by skillful hands and with the due observance of proper sanitary regulations, decided curative properties; not so pronounced and rapid as indicated by the extravagant claims and expectations indulged when it was first introduced, but sufficient to make it a valuable addition to the physician's list of remedies. Upon animals, also, tuberculin has some curative effects, the extent of which has not as yet been fully determined. The use of tuberculin in repeated tests of herds has, therefore, a tendency to arrest the development of incipient cases rather than to assist the progress of the disease, as some writers have suggested. Attempts to effect a cure in this way are not recommended, as the expense would be considerable and the result doubtful. It is far better to remove the source of danger by killing the animals. Any regulations, however, which look to an extinction of the disease must be coupled with rigid sanitary regulations for the destruction of the carcass and disinfection of the stalls, buckets, and the like which could have been contaminated by the diseased animals.

GLANDERS.

The best way to determine the value of a remedy or drug is to place it for use in a number of different hands in widely distributed districts, and then collect and collate the results which have been obtained.

Since the publication in November, 1892 (American Vet. Review), of the experiments which had been conducted by the Bureau of Animal Industry with mallein for the diagnosis of glanders, this product has been prepared in quantity in our laboratory and sent by request to 24 States—south to Texas, west to California, north to Maine, and east to Virginia—and by special request to Manitoba, Canada, and the West Indies. The quantity has been sufficient for testing a large number of horses. Directions for using the mallein and blanks for recording the results were forwarded with each bottle. The amount injected was one cubic centimeter.

Reports have been received covering several hundred cases. Of the entire number only one case was considered doubtful; that is, gave a result which did not prove conclusively whether the animal was diseased or healthy, and this was due to carelessness in the experiment. Dr. Torrance, of Manitoba, Canada, and Dr. Francis, of Texas, have reported the largest number of tests. The tabulated reports of Drs. Torrance, of Canada, Ford and Wheeler, of New Orleans, Graham, of Minnesota, and Hallett, of Pennsylvania, with the accompanying notes, will serve as a fair type of the reactions with mallein and the condition of the animal in general.

The injections of the healthy animals caused a slight rise of temperature, never, however, over 2·5° F., the limit of possible rise in a healthy horse; and the want of accompanying reactions proved the absence of disease.

In several instances the horses examined were very valuable animals and apparently in perfect health. They were injected with the mallein simply because they had been allowed to come into contact with diseased animals. The injection caused a marked rise of temperature and considerable œdema at the point of inoculation, indicating disease. The post mortem examinations confirmed this diagnosis and revealed latent glanders. In the incipient stages of the disease, therefore, before it could be detected by the ordinary methods of diagnosis, but while the animal is in a condition to communicate the disease to other animals as well as man, the mallein is of inestimable value. In this connection the case reported by Dr. Ward is of particular interest.

Last fall a workman was brought to the Johns Hopkins Hospital, suffering and finally dying from a malady which proved to be glanders. At first the way in which he had become infected could not be determined, but finally it was learned that he had been working with a horse troubled with a slight nasal discharge. Otherwise the animal appeared well. An injection of the mallein indicated glanders, and this diagnosis was proven by the autopsy. Had the mallein test been made at an earlier date the horse could have been condemned before any harm was done. The lack of knowledge of the danger to which the workman was exposed was fatal. Cases of a similar nature are by no means of an uncommon occurrence, and as glanders is almost invariably incurable, too much stress can not be laid upon the care which should be observed in handling suspicious animals.

Some newspapers have erroneously made the statement that mallein is exceedingly dangerous. This is a mistake. Small quantities injected produce no harmful results in healthy animals. The germs have been removed in the preparation of the mallein, and the latter is no more dangerous than many other drugs. The only danger in connection with mallein is that to which those who prepare it are exposed, and this is reduced to a mini um by care. Several deaths of scientific men in handling the cultures of the bacillus mallei have been reported, due to some oversight on the part of the operator. These fatalities go to

show that the preparation of the mallein should be conducted with the utmost precaution and care and only where the best facilities for such work exist.

It may be of interest here to refer to the results obtained in the cultivation of the glanders bacillus upon media containing in solution mineral salts and glycerine only. The glanders bacillus grows in such a liquid * fairly well, and as there are present in solution no albuminoid substances, whatever is extracted from the culture after growth can be looked upon as a true product of the germ. From such cultures we have prepared a mallein, which, so far as we have been able to test, gives results as satisfactory as those secured with mallein prepared from beef broth. From this artificial mallein we have obtained an albuminoid substance and a crystalline substance which responds to a number of alkaloid tests. A more complete description of their chemical properties we will give later. They, however, are clearly waste products of the germs, built up and elaborated by the germ from the elements in the solution. They are not simply albuminoid substances which have undergone some change under the action of the germ, but are distinct products of the life of the germ, and would be compared more properly with the albuminoid matter built up in the animal body and its excretions.

In the Archives des Sciences Biologiques, L'Institut Imperial, St. Petersburg (Tome I, No. 5, 1892), is given a review of the experiments upon the preparation and use of mallein in different countries. The results have been uniform, and the mallein proved to be a valuable diagnostic.

Dr. Theo. Kitt gives a review † of the experiments conducted in France and Germany upon very large numbers of horses. The test on the largest number of horses—about 6,000, the property of one of the transportation companies of the city of Paris—was made by Dr. Nocard, one of the ablest veterinary surgeons of France. Several hundred of the horses that responded to the test were killed, and in all either advanced lesions or the primary stages of the disease of the lungs were disclosed by the autopsy.

Some few cases have been recorded in France where an animal that had not reacted exhibited glanders lesions on post-mortem examination. It is a well-established fact that in some instances glanders will cure itself spontaneously or is susceptible of treatment. In these cases the old, broken-down tissues will remain, inactive, however, and harmless, as the source of infection—the germ—is dead or attenuated. In the animals above referred to such was found to be the case, and guinea pigs were not affected by an inoculation with the diseased tissues, showing that the source of infection was dead.

This is a point which has been often overlooked, especially in the examination of tuberculous cattle. The fact that a tuberculous lesion is found in an animal that has not responded to the tuberculin test does not necessarily show that the disease is in an active condition. It must be proved by inoculations upon guinea pigs that the agent of infection is still present and active. On the other hand, if an animal has responded to the tuberculin test and does not show lesions on autopsy, unless this examination has been exceedingly thorough, one can not conclude the disease to be absent, as it is possible that the infection may be present without the disease being sufficiently advanced for noticeable lesions to be formed.

* New York Medical Journal, March 11, 1893.
† Monatshefte für praktische Thierheilkunde, IV bd., II hft., 1893.

In the use of mallein, also, care must be observed in the autopsy of doubtful cases. Nocard reports an instance where the animal did not show the least sign of disease. Submitted to the mallein test the reaction was marked, showing rise of temperature of 4·5° F. The autopsy revealed only small doubtful tubercles in the lungs; otherwise the appearance was normal; but a very careful examination of the lungs showed deep-seated ulceration characteristic of glanders.

In the use of mallein cases that give a decided reaction and are suspicious may be safely destroyed at once. Others that are only suspicious should be isolated and submitted to the mallein test three times successively, with an intermission of a week or ten days each. If, then, they have not shown the characteristic reactions, they can be safely considered well. While mallein can not be pronounced an infallible test to be used alone without taking into consideration other symptoms, it is an invaluable addition to the list of diagnostic means, and its great value lies in the possibility of detecting incipient cases of disease, and thereby avoiding its communication to other animals and men and consequent loss of life and valuable property. Coupled with proper regulations for disinfection, we may see the time at no distant day when glanders will be very rare or unknown, and will be referred to as a very dangerous disease that at one time caused great loss.

The following notes were attached to the cases reported by Drs. Torrance, Ford and Wheeler, Graham, Hallett, and Kurtz:

EXPERIMENT I.—*By Drs. F. B. Ford and Wheeler, New Orleans, La.*

Mule, healthy, No. 1.			Glandered, No. 2.			Healthy, No. 3.			Glandered No. 4.
Date.	Time.	Temperature.	Date.	Time.	Temperature.	Date.	Time.	Temperature.	Temperature.
			Before injection.						
....	....	....	Apr. 19	10 a. m....	100	Apr. 28	3 p. m.....	99	101·6
....	....	....	...do	6 p. m.....	100·4	....	....	....	....
....	....	....	Apr. 20	....	....	....	....	....	....
			After injection.						
Apr. 20	9:30 a. m..	100	...do....	9:30 a. m..	99·6	Apr. 29	10:30 a. m.	99·4	102
Do....	11:30 a. m.	100	...do....	11:30 a. m.	100	...do....	12:30 p. m.	100	102·2
Do....	1:30 p. m..	100	...do....	1:30 p. m..	100	...do....	2:30 p. m..	100	102·8
Do....	3:30 p. m..	101·2	...do....	3:30 p. m..	101·2	...do....	4:30 p. m..	100	102·8
Do....	5:30 p. m..	102	...do....	5:30 p. m..	101·4	...do....	6:30 p. m..	100	103·2
Do....	7:30 p. m..	101·4	...do....	7:30 p. m..	103·7	...do....	8:30 p. m..	100	103·2
Do....	9:30 p. m..	101·4	...do....	9:30 p. m..	104	...do....	10:30 p. m.	100·2	103 4
Do....	11:30 p. m.	....	...do....	11:30 p. m.	....	...do....	....	....	....
	Slight swelling.			Large swelling.					Swelling.
Apr. 21	7:30 a. m..	100·8	Apr. 21	7:30 a. m..	101·9	Apr. 30	8:30 a. m..	99	103
Do....	12 m......	100	...do....	12 m......	102·1	...do....	1:30 p. m..	99·6	103
Do....	7 p. m.....	100·2	...do....	7 p. m.....	100·6	...do....	6:30 p. m..	100	103·6

No. 1.—This was a perfectly healthy mule, and, while it showed a very slight reaction and swelling, it was not diseased. It served as a control test for No. 2, which had been exposed to glanders and had enlarged submaxillaries, tubercles on the nasal septum, and a slight nasal discharge. The post-mortem revealed marked pulmonary glanders with tubercles in every stage. This horse had been the cause of the death of seven head of stock. No. 3 served as control animal for No. 4. The mule No. 4 was in the same stable as No. 2, and showed discharge at the nose and ulcers in the septum. Three days after injection the animal died and ulcers appeared over the surface of the body.

EXPERIMENT II.—By *Christopher Graham, St. Anthony's Park, Minn.*

Not glandered, No. 1. (Before injection.)			Not glandered, No. 1. (After injection.)		
Date.	Time.	Temperature.	Date.	Time.	Temperature.
1893.			1893.		
Apr. 15	5:30 p. m.	101	Apr. 18	10 a. m.	101·2
Do	9 p. m.	101	Do	12 m	101
Apr. 16	7:30 a. m	101·5	Do	2 p. m	101
Do	12 m	101	Do	4 p. m.	101·4
Do	10:30 p. m.	101·5	Do	6 p. m.	101·4
Apr. 17	6 a. m	101	Do	8 p. m.	101·4
Do	8 a. m	101·5	Do	10 p. m.	101
Do	10 a. m.	101·5	Apr. 19	6 a. m	101·4
Do	12 m	101·5	Do	8 a. m	101·2
Do	2 p. m.	101·5	Do	10 a. m	101
Do	4 p. m.	101·5	Do	12 m	101
Do	6 p. m.	101·5	Do	2 p. m.	101·4
Do	8 p. m.	101·5	Do	4 p. m.	101·4
Do	10:30 p. m.	101·5	Do	6 p. m.	101·4
Apr. 18	6 a. m.	101	Do	8 p. m.	101·4
Do	8 a. m.	101·4	Do	10:30 p. m.	101

No. 1.—This was an imported animal suffering with chronic grease and had enlarged lymphatic glands.

EXPERIMENT III.—*W. R. Hallett, Oswego, Pa.*

Date.	Glandered No. 1.		Glandered No. 2.	Healthy No. 3.	Healthy No. 4.
	Time.	Temperature.	Temperature.	Temperature.	Temperature.
	Before injection.				
1893.					
January 19	8 a. m	98·7	100·5	100	100
Do	12 m	100	102	100·5	100
Do	5 p. m	100	102	100	100
	After injection.				
January 20	9 a. m	99·5	100·5	100	100
Do	11 a. m	102·5	101·1	100	100·7
Do	1 p. m	102·5	102·2	100·7	100·7
Do	3 p. m	105·7	103	100	100
Do	8 p. m	105·2	104·1		
Do			104·1		
	Large swelling.		Large swelling.	No swelling	Swelling for 1 week; cause unknown.
January 22	9 p. m	Normal	104	Normal	Normal.

No. 1.—This horse was in good condition, but showed a glanders reaction. No. 2 had a slight mucous discharge from the nose and was a suspected case. Nos. 3 and 4 were both healthy.

EXPERIMENT IV.—*By Dr. Kurtz, Appleton, Wis.*

No. 1.—This was a bay stallion, standard bred, 6 years old, which had a gluey discharge from both nostrils, an occasional cough, with a tender hard swelling between the jaws, and ulcers of the mucous membrane of the nose. Its appetite and general life were good. The injection of the mallein caused a rise of temperature of 4½°, a swelling on the neck 10 in. wide and 14 in. long, with a loss of appetite. The swelling on the neck was so hard and tender that the animal was unable to move its head up or down for two days. The swelling persisted up to the time that the animal was destroyed, which was about five days after the injection.

No 2.—This was an 8-year old sorrel gelding, which had a slight discharge at the nose, and the right hind leg slightly swollen. Otherwise it was apparently healthy. The injection of the mallein caused neither swelling nor other inconvenience. Dr. Kurtz adds that the tests with mallein were very satisfactory and that he considered its use important and very reliable.

EXPERIMENT V.—*By F. Torrance, Brandon, Manitoba, Canada.*

Date.	Glandered No. 1. Time.	Glandered No. 1. Temperature.	Healthy No. 3. Temperature.	Not glandered No. 3. Temperature.
	Before injection.			
1893.				
January 24	11 a. m.	101	100 ·2	100 ·2
Do	5 p. m.	100 ·8	101	101 ·8
Do	11:30 p. m.	100 ·4	100 ·2	100 ·8
January 25	10 a. m.	99	100 ·8	99 ·6
Do	4:30 p. m.	101	100 ·8	100 ·4
Do	9:30 p. m.	101 ·2	100 ·8	100 ·8
	After injection.			
January 26	8:45 a. m.	100	101	99 ·4
Do	10:45 a. m.	101	100 ·8	99 ·2
Do	12:45 p. m.	101 ·4	101	100
Do	2:45 p. m.	102 ·6	101 ·6	101
Do	4:45 p. m.	103 ·6	101 ·8	101 ·8
Do	6:45 p. m.	105	101 ·2	101 ·8
Do	8:45 p. m.	105 ·2	101 ·8	101 ·8
Do	10:45 p. m.	104 ·6	101 ·6	101 ·8
	Large swelling.		Very slight swelling.	No swelling.
January 27	10 a. m.	101. 6	101 ·4	101 ·8
Do	4 p. m.	102 ·8	101 ·4	100 ·2
Do	8:30 p. m.	103	101 ·2	101 ·2
January 28	10:30 a. m.	102 ·2	100 ·2	....

Date.	Healthy No. 4. Time.	Healthy No. 4. Temperature.	Glandered, No. 5. Temperature.	Glandered, No. 6. Temperature.	Glandered, No. 7. Temperature.	Glandered, No. 8. Temperature.	Glandered, No. 9. Temperature.	Farcy, No. 10. Temperature.	Glandered, No. 11. Temperature.	Not glandered, No. 12. Temperature.
			Before injection.							
1893.										
February 23	11 a. m.	100 ·2	100 ·6	101 ·4	100 ·8	100 ·8	101	102 ·6	102 ·8	102
Do	10:30 p. m.	100	100 ·6	101 ·4	100	100 ·8	100 ·4	102 ·2	101 ·6	102
			After injection.							
February 24	8 a. m.	98 ·8	100	100 ·4	98 ·8	99 ·8	100 ·4	101	101 ·4	102 ·2
Do	10 a. m.	99 ·6	101	102	101 ·4	100	101	102 ·2	102 ·4	102 ·8
Do	12 m	99 ·6	101 ·2	102 ·4	102 ·8	100 ·6	101 ·8	103	102 ·8	101 ·4
Do	2 p. m.	99 ·4	102 ·2	102 ·4	103 ·6	101 ·4	103	102 ·6	103	101 ·6
Do	4 p. m.	100	104	103 ·4	104 ·6	103 ·4	103 ·6	103 ·6	103	101 ·4
Do	6 p. m.	100 ·4	104	104	104 ·6	103 ·8	104 ·2	103 ·6	102	102
Do	8 p. m.	100 ·2	104 ·4	104	104 ·4	104 ·6	104 ·4	103 ·2	102 ·8	102 ·4
Do	10 p. m.	99 ·8	103 ·6	104	104 ·2	104 ·8	104	102	102 ·4	102 ·4
		Very slight swelling.	Swelling.	Large swelling.	Swelling.	Very large swelling.	Swelling.	Large swelling.	Swelling.	No swelling.
February 25	10 a. m.	99 ·4	104	104	103	103 ·8	104 ·8	102	102	102
Do	4 p. m.	99. 4	103 ·4	103 ·8	103 ·4	103 ·4	104 ·4	103	102 ·6	102 ·4
Do	8 p. m.	100 ·2	103 ·4	103 ·6	101 ·8	102 ·8	103 ·6	102 ·4	102 ·2	103 ·6
February 26	12 m	99 ·4	102 ·8	103 ·4	101 ·2	102 ·6	102 ·2	101 ·8	101 ·4	102
....	....	....	101 ·4	....	....	....	....	....	....	102 ·2
....	....	....	....	....	....	....	....	....	....	101

EXPERIMENT V.—*By F. Torrance, Brandon, Manitoba, Canada*—Continued.

Not glandered, No. 13.		
Date.	Time.	Temperature.
	Before injection.	
1893.		
Feb. 27	6 p. m	103.8
Feb. 28	do	103.8
March 1	11 a. m	101
Do	6 p. m	102
	After injection.	
March 3	8 a. m	102
Do	10 a. m	102

Not glandered, No. 13.		
Date.	Time.	Temperature.
	After injection.	
1893.		
March 3	12 m	102.2
Do	2 p. m	102.2
Do	4 p. m	102.2
Do	6 p. m	102.4
Do	8 p. m	102.2
Do	10 p. m	101.6
Do	11:30 p. m	101. No swelling; had strangles.
March 4	10 a. m	101.4

No. 1.—This animal was an aged stallion in fair condition that had enlarged submaxillary glands and nasal discharge for some time. There was, however, no history of contagion. The injection showed the animal to be glandered.

No. 2.—This control, a working mare, was in fair condition, and did not respond to the injection.

No. 3.—An aged mare in poor condition had enlarged, nodulated submaxillary glands and a sticky nasal discharge. The result of this injection was negative, but there had been no history of contagion.

No. 4.—This was an aged, healthy sorrel mare.

No. 5.—Was an aged mare which had had enlarged submaxillary glands that had opened and discharged, but no nasal discharge. Two hours after the injection the mare had cold and rigors; was dull and off feed for two days.

No. 6.—Was an old sorrel gelding, apparently healthy, which had some time before been troubled with sores on its legs that healed. After the injection the animal was dull and off its feed for two days, giving also the other characteristic glanders reactions.

No. 7.—This case was No. 1 reinjected.

No. 8.—This was a bay colt which some time before injection had enlarged submaxillary glands, but at the time of injection was apparently healthy. The reaction would indicate that the animal was still diseased.

No. 9.—This was a yearling filly, apparently healthy, but gave a decided reaction.

No. 10.—This was a black colt, about 9 months old, which had a few farcy ulcers on leg and flank.

No. 11.—A sorrel colt, 1 year old, which was affected with glanders and farcy. The post mortem revealed glandered nodules in the lungs, a caseous abscess in the bronchial glands, and extensive ulceration of the nasal septum. The temperature of the animal was high before the injection.

No. 12.—This was a bay mare affected with pneumonia of seven days' standing.

No. 13.—This was a sorrel filly affected with strangles, and had some nasal discharge and swelling of the submaxillary glands. The temperature here again was too high before the injection for the latter to be of use.

Two cases of mild farcy were taken to the station of the Bureau about a year ago and treated by repeated injections of mallein. They both apparently recovered. The one case, however, while outwardly well, still responded to the mallein test, was killed and found diseased. The other animal does not give any reaction with mallein, and is in use and quite well. There are also some other cases on record where the animals appeared to have recovered after the injection of the mallein. It is, however, far better to exterminate the disease than to wait for a possible cure.

When we take into consideration the fact that the disease can readily be contracted by man from the horse and is practically incurable, and that one diseased animal may communicate it to a large number of other valuable ones, the importance of preventive legislation is at once apparent. The disease is readily communicated by means of the nasal secretions, so that the promiscuous use of water troughs, stalls, and buckets is dangerous, and the coughing of a horse may serve to carry the infecting material to man and other horses.

MISCELLANEOUS INVESTIGATIONS.

In connection with the investigations of the cornstalk disease a number of examinations of cornstalks have been made, with the detection, however, of no poisonous alkaloid.

At the request of the Division of Botany, an investigation of the plant *Artemisia tridentata*, the sagebrush of the western plains, was begun. This, the Chief of the Division of Botany informs us, is used very largely by the natives as a febrifuge. A preliminary examination has revealed the presence of an alkaloid, a volatile and nonvolatile oil, and several gums in considerable quantity, so that a more extended study has been undertaken with the intention of determining the physiological effect of the alkaloid and other products and their possible practical use.

The subject of the milk and butter ferments, which give to butter their agreeable or bad flavor, has been pretty well studied in Denmark, and the best brands of butter there are made with the use of the ferments upon sterilized milk only which will produce the desired flavor. In this country Conn, of Connecticut, has also isolated a number of different germs which also, in their action upon milk, give butter of a desirable flavor.

As the action of these ferments is to produce, just as in the case of pathogenic bacteria, chemical products, which products impart to the butter the peculiar flavor, experiments have been begun to isolate, study, and, if possible, prepare synthetically some of these substances with a view to their practical use.

As an easy way of removing and destroying the ticks upon Southern cattle is exceedingly important, as these parasites are so intimately related to Texas fever, we have had tested at the station a number of different sheep dips and disinfectants which are so widely advertised and recommended. The ticks were placed on the cattle and then the infected surfaces washed with the solution. None of the materials used were satisfactory. The list included thymo-cresol, creoline, Quibble's sheep dip, fernoline, sodium sulphite, sulphuretted hydrogen, Hayward's sheep dip, kerosene, and gasoline. Dr. Francis, of Texas, reports the successful use of kerosene, but our results were not satisfactory, and we must search for a more reliable substance for the destruction of the parasites.

Other routine analyses have been made, and some time was devoted to the preparation of an exhibit for the World's Fair, indicating the line of work of this laboratory and its practical application, especially to tuberculosis and glanders.

REPORT OF THE CHEMIST.

SIR: I submit herewith a report of the work done in the Division of Chemistry during the year ending December 31, 1893.

Very respectfully,

H. W. WILEY,
Chemist.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE DIVISION AT THE WORLD'S FAIR.

ARRANGEMENT OF LABORATORY APPARATUS AND FIXTURES.

An attempt was made at the Columbian Exposition in Chicago to exhibit the work of the Division of Chemistry in a practical way. There is little of interest in a chemical exhibit which shows simply apparatus and chemical appliances without in any way portraying chemical work. It was believed that the most valuable method of showing to the people the utility of an exhibit of this kind would be by having chemical work in progress. In the arranging of the apparatus, therefore, this end was kept in view, and some difficulty was experienced in so arranging the fixtures and apparatus as to secure a pleasing exhibit and at the same time not interfere with practical work. Nevertheless, the idea of an exhibit was not abandoned as such, and an attempt was made to so dispose the apparatus that the part of it which was not in use should at all times be open to the inspection of the public. These conditions made the arrangement of the laboratory for the double purpose a matter of considerable study.

The work tables of all descriptions were arranged with a view to the provision of a large amount of storage room. They were covered with tiling and painted white and finished with an enameled surface. Each of the analytical tables was provided with a large number of gas connections, water service, etc.

Among the special features of the laboratory was a complete outfit for use in the analysis of sugar beets for purposes of seed selection. This apparatus consisted largely of special rasps for removing and pulping a portion of the beet for analysis. Apparatus for the analysis of beets for manufacturing purposes was also exhibited.

The apparatus for the examination of ordinary agricultural products was also complete, and represented the most modern forms adopted for this purpose.

PRACTICAL TESTS AND ANALYSES.

The practical work which was accomplished during the continuation of the World's Columbian Exposition was as follows:

Sugars.—The number of samples of sugar analyzed for the jury of awards was 454. The examination consisted solely of the polarization of the sugar for the purpose of determining its saccharine value. The judges of awards based their decisions largely on the results of this polarization. The sugars examined consisted not only of those of domestic origin, including cane, sorghum, beet, and maple sugars, but also foreign exhibits from every sugar-producing territory.

Whiskies, brandies, etc.—A large number of samples of whiskies, brandies, and liquors was also analyzed for determining their percentages of sugar and alcohol.

Olive oils.—Olive oils of foreign and domestic origin, numbering in all 128, were examined to determine their purity.

Tannin.—For the determination of the tanning value of the various materials exhibited for that purpose, many samples were analyzed and the percentage of tannin therein accurately determined.

Baking powders.—All the baking powders and so-called yeast powders on exhibition were also analyzed and the percentage of leavening power determined, and this analysis was used as the basis of the awards.

Hops.—All the samples of domestic and foreign hops were also subjected to a careful chemical analysis to determine their percentage of extract given up to ether and alcohol, the percentage of moisture which they contained, and their total percentage of nitrogen. These data were also used in making the awards in this class by the jury.

Cereals.—The most laborious analyses made, however, were those of the cereals. In all 532 samples of cereals and cereal products were examined. The analysis consisted in the determination of the moisture, ash, nitrogen content, percentages of oil and indigestible fiber; the digestible carbohydrates being determined by difference in the usual way. Based on the data obtained by analysis, the food values or nutritive values of these samples were calculated. In this calculation the relative value of the different nutritive principles was fixed as follows: The starch and soluble carbohydrates were represented by a nutritive value of 1; the fats and oils by a nutritive value of 2.5, and the albuminoids, obtained by multiplying the percentage of nitrogen by 6.25, by 2.5. The total nutritive value of the cereal was calculated on the above basis. The following may serve as an example:

Let a sample of wheat have the following composition:

	Per cent.
Water	7·54
Ash	1·81
Oil	2·29
Fiber	1·64
Albuminoids	12·53
Starch and soluble carbohydrates	74·19

The relative nutritive value of this wheat would then be—

$$\begin{aligned} 74{\cdot}19 \times 1{\cdot}0 &= 74{\cdot}19 \\ 2{\cdot}29 \times 2{\cdot}5 &= 5{\cdot}73 \\ 12{\cdot}53 \times 2{\cdot}5 &= 31{\cdot}33 \\ \hline \text{Sum} \ldots\ldots &\; 111{\cdot}25 \end{aligned}$$

The data obtained in the analyses of the cereals on exhibition will prove of great value in fixing a standard of excellence for the cereal

products of all quarters of the world. It is to be presumed that the cereals on exhibition represented the best products of all countries. Of the samples on exhibition only the very best were selected by the judges for chemical analysis. It is therefore but just to assume that the data obtained in these analyses represent the very best that can be furnished by each particular country. It is believed, therefore, that a detailed report of these analyses will prove of the greatest interest to agricultural chemists throughout the world, and it is the intention to make such a report as soon as possible.

Artificial colors.—Examination was also made for the jury of awards of the artificial colors used in butter and cheese. Most of these, as would be expected, were annatto ground in oil. Some of them, however, were found to be colors of aniline origin, probably tropaeolin. The use of annatto in coloring butter and cheese is in most countries permitted by law, but the use of other coloring matter of doubtful hygienic effect is something to be discouraged. In all cases it was recommended that no award be given to butter colors other than those composed of annatto.

Beers, ales, porters, stouts.—The analyses of the beers, ales, porters, and stouts which were on exhibition excited perhaps more interest than any other series of analyses undertaken at the World's Exposition. The great rivalry between leading brewing firms created a widespread interest in the results of the work. The awards which were made on the exhibits of malt liquors were based partly on the judgment of the jury of experts and partly on the results of the chemical analyses. Inasmuch as there has been widespread comment made upon the methods of analysis employed, it has been thought wise to give in brief a resumé of them. In doing this it has been found desirable to add the results of some special experiments, made since the closing of the Fair, to determine the chemical composition of beers of known origin. These beers were brewed on a small scale in the laboratory, so that we were absolutely certain of the materials of which they were composed. As will be seen, the general result of this examination shows, with one or two exceptions, the entire validity of the basis of judgment employed.

In the preparation of the samples of beers of known components no attempt was made to produce an article which would be equal as a beverage to the beers of commerce. Indeed, it was well understood that such an attempt would be in vain.

The expert treatment of malt and its substitutes necessary to produce a sparkling and attractive beverage can be secured only in commercial or model breweries. The object we had in view, however, was fully accomplished by the experiments, as it was the chemical and not the commercial character of the beers which was to be investigated.

BEER ANALYSES FOR JURY OF AWARDS.

The analyses of domestic and foreign beers made by the Division of Chemistry for the jury of awards at the Columbian Exposition are valuable in helping to fix a standard for the judgment of fermented liquors. The following standards were fixed in advance for the chemical tests:

Alcohol—
- For beers .... 3 to 6 per cent
- For ales, porters, etc .... 5 to 9 per cent

Albuminoids—
- Minimum percentage for malt products .... 0.5 per cent

No limits were fixed for ash extract and polarizing bodies. Where the alcohol fell without the limits fixed, 2 points were deducted from the total allowed in the chemical judgment, viz, 45 points. The same deduction was made for a deficiency of albuminoids.

The presence of salicylic acid in moderate quantities in the beer, as determined by the qualitative test, indicated the deduction of 2.5 points from the total, and its presence in large quantities the deduction of 5 points.

In the qualitative examination of the ash the presence of a considerable quantity of hydrochloric acid indicated a subtraction of 2 points and of a large quantity of 3 points from the total.

The same rule was made in regard to the presence of considerable and large quantities of sulphuric acid. These tests were, however, qualitative only.

In testing for hydrochloric acid a mere opalescence or pronounced opalescence was neglected, as it could have come from the water used in brewing, and the same rule was made in regard to sulphuric acid. A moderate precipitation in each case was taken as an indication of the presence of a considerable quantity and 2 points deducted accordingly. A heavy precipitation in each case indicated the presence of a large quantity and 3 points were deducted. These recommendations were made in such a way, if possible, as to cover the fact that in many waters used in brewing considerable traces of both hydrochloric and sulphuric acids are found. This is notably true of the water used by the brewers in Burton on the Trent, where as much as 25 grains per gallon of sulphate of calcium are found in some of the waters used, and as much as 10 grains per gallon of chloride of sodium.

It is not the purpose here to enter into a discussion of the merits of saline waters in brewing as compared with those of pure waters. It is, however, believed that beers containing large quantities of sulphates and chlorides can not be regarded in the same light in relation to health as those which contain only moderate quantities or traces of these bodies. This remark is especially applicable to the presence of sulphates.

In regard to the albuminoid percentages, the standard was fixed because it was believed that when a pure malt had been used in brewing the percentage of albuminoids would be constantly, or almost always, above one-half of 1 per cent. The use of rice or glucose as a partial substitute for malt would therefore tend to diminish the percentage of albuminoids in the beer. As is well known, the presence of an excess of albuminous matter in beer tends to produce cloudiness, and it is also the nidus for subsequent and injurious fermentation. It is not, therefore, implied by fixing a standard in this way that a high percentage of albuminoids is desirable in beer, but the object of the standard is to determine whether or not pure malts have been used in brewing.

The quantity of solid matter contained in the beer and its polarization were not considered in determining its grade number, but these determinations were made in order to complete so far as possible the analysis in the short time allowed for the work. No attempt was made to determine whether any bitter principles other than those present in hops had been used in the brewing.

BEERS BREWED IN THE DEPARTMENT LABORATORY.

Before giving the data representing the composition of the beers exhibited, it is desirable to call attention to the numbers obtained in the examination of some beers brewed in the laboratory of the Depart-

ment of Agriculture. These beers consist of pure malt beers and beers made by mixtures of malt and barley, glucose, rice, and hominy grits in varying proportions. The beers were all brewed in the same way and under the same conditions. They therefore give an excellent basis for comparison with beers brewed from unknown materials. It is not unusual for brewers to maintain that they use nothing but pure malt and possibly barley in making their beers, but it is not always safe to accept assurance of this kind as a basis of scientific investigation. The water employed in our home brewing was Potomac water, which, as is well known, contains only a small quantity of saline matter, not to exceed 6 grains per gallon. In one instance, additions of saline matter, notably gypsum, were made to the water for the purpose of making it resemble in some respects the waters used in the breweries at Burton on the Trent.

Following are the results of the analyses of these home-brewed beers:

Analyses of the home-brewed beers.

Serial number.	Letter.	Specific gravity 15.5° C.	Alcohol volume.	Alcohol weight.	Albumen.	Polarization.	Extract.	Ash.
			Per cent.	*Per cent.*	*Per cent.*	*Degrees.*	*Per cent.*	*Per ct.*
12,865	A	1·0237	3·88	2·97	·1282	17·3	7·51	·102
12,866	B	1·0164	4·72	3·70	·5657	8·4	5·35	·252
12,867	C	1·0163	4·75	3·73	·1188	7·9	5·83	·184
12,868	D	1·0123	5·58	4·39	·2563	7·1	5·09	·212
12,869	E	1·0249	4·05	3·16	·1375	17·9	7·62	·139
12,870	F	1·0188	4·91	3·86	·2938	13·9	6·35	·155
12,871	H	1·0212	4·50	3·51	·2657	14·5	6·84	·337
Malt*		1·0096	3·66	2·85	·5625	5·2	4·00	·294
Glucose*		1·0116	5·60	4·41	·1250	7·2	5·30	·196

* To which gypsum was added.

The quantities of grain, etc., used in the preparation of these beer samples were as follows:

A.—200 grams malt....800 grams rice.
B.—1 kilo malt.
C.—200 grams malt....800 grams glucose.
D.—500 grams malt....500 grams glucose.
E.—200 grams malt....800 grams corn grits.
F.—500 grams malt....500 grams corn grits.
H.—500 grams malt....500 grams rice.

Sample A.

The rice in the case of sample A was stirred into 3 liters of boiling water and the mixture placed on the steam bath. When the rice became a paste, it was removed and allowed to cool to 65° C. The malt was then added and the temperature kept at that point for two hours. The wort was then strained off through a sieve, 2 liters more water added to the grains, and mashing resumed at 65° C. for another hour. The wort was then strained off through a sieve and the grains pressed in a cotton bag. The united worts were treated as given below.

Sample B.

The malt in sample B was placed in 3 liters of cold water and the temperature gradually raised to 65° C. The rest of the operation was as just described.

Sample C.

In sample C the glucose was dissolved in 3 liters of boiling water, the temperature allowed to fall to 65° C. and the malt added. The rest was as above.

Sample D.

Sample D was treated exactly as was sample C.

Samples E, F, and H.

Samples E, F, and H were treated in exactly the same way as sample A.

TREATMENT OF THE WORTS.

The united worts in each case were brought to a boil, 15 grams of hops added, and the boiling continued fifteen minutes. The liquid was then placed in a flask under the tap until the temperature was 12 to 15° C., and then filtered. The mixture of coagulated albuminoids and exhausted hops remaining on the filter was mixed with the grains resulting from the mashing. The density of the wort was taken and when necessary cold water (previously boiled) was added till the density reached about 14° Brix. The volumes, densities, and polarizations of the resulting liquids were as follows:

Sample.	Cubic centimeters.	Total solids.	Polarization.	Total solid matter.
		0° *Brix*	*Degrees.*	*Grams.*
A	3,680	12·8	29·2	521·8
B	4,000	13·0	20·4	547·6
C	5,200	13·5	16·1	740·6
D	4,700	14·5	18·2	721·7
E	3,200	14·5	29·5	491·4
F	3,300	14·5	26·9	506·7
H	4,100	14·5	26·8	629·6

To each portion of wort were added 5 grams of hops and 200 cubic centimeters of Heurich's yeast. Portions for the polarization were measured out before the addition of the yeast. The addition of yeast took place at 10 p. m., December 9. On December 13 at noon the beers were filtered and bottled.

REMARKS ON RESULTS OF BEER ANALYSES.

The analysis of the samples of home-brewed beers fully bears out the wisdom of the selection of 0.5 per cent as the limit for albuminoids for pure malt beers. The other analyses show also, without the least particle of doubt, the admixture of other bodies with the malt. Before knowing the origin of the beers we took the table of analyses and were able to correctly indicate the proportion of malt in each sample by the percentage of albuminoids alone. Even in the case of the grits, which contained a considerable quantity of albuminous material, it is seen that the percentage of albuminoids is very slightly increased over that for the rice or glucose, showing conclusively that the malt is practically the sole source of the albuminoid matter in the beer. It thus appears to be demonstrated that the percentage of albuminoid in a beer is a direct criterion of the percentage of malt employed in the brewing.

The analyses of the home-made beers also show that the standard for alcohol adopted is a proper one. Only one of the nine samples examined fell below the standard, and this was doubtless due to the shortness of time allowed for fermentation.

On the other hand, in regard to the qualitative test for sulphates, the matter is not so clear. Inasmuch as in European countries highly sulphated waters are employed, it is not strange to have always found in these European beers a very large amount of sulphuric acid. In the American beers, however, the amount of sulphuric acid present in most cases is neglectable and only in a few cases did the grading of the beer suffer from the amount of sulphuric acid it contained. It seems, therefore, that the reaction for sulphuric acid is in no just sense a criterion for the addition of glucose or even of sulphites, and in fixing a scale of points, deducting a certain percentage from the grade of the beer for heavy reactions for sulphates should be practiced, not because it would indicate the presence of glucose in the brewing or even of sulphurous acid as a preservative, but simply because the presence of a large amount of sulphuric acid in a beverage is or may prove harmful.

In regard to the reaction for common salt, the matter appears somewhat plainer. Although common salt occurs constantly in waters used for brewing, yet it is not present in such quantities as to produce a

heavy, curdy precipitate in a solution of the ash. Unless attributed to mineral or other extraordinary qualities in the water, the occurrence of a moderately curdy precipitate or a heavy curdy precipitate on the addition of a solution of nitrate of silver to a nitric-acid solution of the ash would indicate the addition of common salt in the brewing. The addition of common salt in moderate quantities is not in any way prejudicial to health, but when the question which was to be decided in these cases is this, viz, Has anything been added beside the malt, hops, yeast, and water? then the presence of hydrochloric acid must be noticed. If, therefore, the analysis indicate the addition of common salt, on this hypothesis it will be proper to correspondingly diminish the number showing the grade.

The total number of beers, etc., examined is as follows: Wood beers, 102 samples; bottled beers, 130 samples. In the above term "beer" is included, of course, all the various forms of malt liquors, such as beers, ales, porters, stouts, etc. In addition to these quite a number of malt extracts was also examined for the jury of awards.

The total number of analyses made for the bureau of awards was 1,687.

EXPERIMENTS WITH SUGAR BEETS.

In harmony with the provisions of the act of Congress providing for experiments in the improvement of sugar-producing plants and the manufacture of sugar therefrom, the work of the Department in this direction was continued in two distinct lines.

The first of these consisted in the distribution of beet seed to those interested in the culture of the beet, as indicated in the report of last year. The Department having made no purchase of beet seed for distribution, Mr. H. T. Oxnard kindly donated for its use a sufficient quantity of the best imported seed.

SUGAR-BEET SEED DISTRIBUTED.

The number of packages of seed sent out was 2,428, and the number of persons to whom sent 348. The number of packages sent to each of the different States and Territories receiving seed was as follows:

	Packages.		Packages.
Alabama	12	Montana	2
Arizona	1	Nebraska	120
Arkansas	32	Nevada	50
California	347	New Jersey	10
Colorado	202	New Mexico	52
Connecticut	1	New York	90
Delaware	10	North Carolina	5
Florida	3	North Dakota	34
Georgia	200	Ohio	68
Idaho	4	Oklahoma	8
Illinois	17	Oregon	6
Indiana	83	Pennsylvania	3
Iowa	62	Rhode Island	3
Kansas	12	South Dakota	176
Kentucky	3	Tennessee	15
Louisiana	111	Texas	4
Maine	1	Virginia	33
Maryland	13	Washington	250
Michigan	43	West Virginia	1
Minnesota	69	Wisconsin	219
Mississippi	14	Wyoming	12
Missouri	27		

The number of packages of seed distributed was far less than in previous years, and the number of samples received for analysis was correspondingly diminished. The total number of samples received at the Chicago laboratory was 199, and the total number of samples received at the Washington laboratory was 84.

Accompanying each package of seed there was sent a copy of Farmers' Bulletin No. 3, which contains detailed instructions for preparing the land, planting the seed, and cultivating the beets.

SUGAR-BEET ANALYSES AT THE WORLD'S FAIR.

Arrangements were made for taking samples for analysis and these samples were sent chiefly to the chemical laboratory of the Department at the World's Columbian Exposition. As has already been indicated, one of the chief features of the chemical laboratory at the Exposition was the arrangement for the analyses of beets. In addition to this the Chicago laboratory was nearer to the localities in which the beets were chiefly grown, so that they could be sent for analysis in a shorter time than if forwarded to Washington. It was thought also that it would be an excellent illustration of the practical work of the laboratory to have the analyses made where they could be viewed by those interested. The wisdom of this course was apparent from the fact that at all times when analyses of beets were in progress large numbers of intelligent observers were watching the work. The questions which they asked showed that they were interested in the process and were receiving valuable instruction from observing it. Some of the samples of beets, however, were sent to the laboratory at Washington for examination.

UNSATISFACTORY RESULTS OF EXPERIMENTS.

The general results of the work this year were somewhat discouraging as compared with those of previous years. Throughout a great part of the beet-growing region the summer was excessively dry and large numbers of total failures were reported.

In former reports attention has been called to the fact that the present method of experiment is unsatisfactory, and the reasons therefor have been fully set forth. The farmers are so busy with other work that as a rule they are not able to give the proper attention to the experimental details. They do not have time to properly prepare the soil for beet culture, nor do they give to the growing beet proper attention. When the time for harvesting comes they are usually engaged in other farm work, so that the beets are not harvested at the proper time, nor are proper data obtained by means of which any accurate estimate of the yield per acre can be determined. The analytical data, therefore, of such work are usually fragmentary and far from teaching any valuable lesson in regard to the industry itself. In general, however, the data bear out those of previous years in showing the areas in this country where the best beets can be grown. It is in these regions that the development of the industry must be expected.

There is probably not a State or Territory in the Union which is not capable of growing sugar beets of fair quality. Even in the far South beets of fair sugar content have been produced, and with good tonnage, but when the competition of the world is to be met, with the price of sugar as low as it is now, only those parts of the country where the soil and climate are especially favorable can be expected to compete successfully with the beet-sugar industry already firmly

established in older countries. The sole valuable lesson, therefore, of this promiscuous distribution of beet seed is in the fact that as a rule those regions best suited to the growth of the sugar beet will gradually be outlined, and intending investors led to the proper localities for the establishment of factories.

The great success of the beet-sugar industry on the Pacific coast leads to the conclusion that if the northern part of the eastern and central portions of our country is to become the seat of a great sugar industry, every possible advantage must be taken of soil and location in order to compete successfully with the beet fields of California, Washington, and Oregon.

A LIMITED DISTRIBUTION OF HIGH-GRADE SEEDS.

It is not believed that further experiment with the promiscuous distribution of seed will be of any practical benefit. Nevertheless, many farmers apply each year for samples of seed, and incidentally some good can be done by supplying them with what they need. It is not necessary to enter into an argument here to show that the farmer will not be able on his own motion to secure beet seed of high grade. He can not even be sure that the sugar-beet seed offered by dealers is anything more than the seed of the common beet. He does not know the addresses of the growers of beet seed of established reputation. Even if he did, the cost and trouble of securing 2 or 3 pounds from abroad would be so great as to deter him from making the attempt. It seems proper to the writer, therefore, that as long as the Department is engaged in the distribution of seeds it should send to those who inquire for them small samples of the highest-grade beet seed which can be produced. While most of the samples will be productive of no great good, yet now and then one may reach a locality where it will excite interest, and possibly do much toward the future development of the industry. In addition to this it is not to be forgotten that the cost of sending out a few thousand packages of beet seed is very small, and the chemical analyses are secured without expending a single dollar over the usual cost of conducting the laboratory. If the farmers receiving these gifts of the Department would learn the single lesson of appreciating the scientific agriculture which has made the sugar beet possible, it would be an ample repayment of the whole cost of distribution.

EXPERIMENTS AT SCHUYLER, NEBR.

The experimental station at Schuyler, Nebr., established for the purpose of improving the sugar beet and demonstrating the most approved methods of its cultivation, was continued during the growing season of 1893.

THE SELECTION OF MOTHER BEETS.

During the previous autumn the different standard varieties of beets, as harvested from the experimental plats, were carefully culled for the selection of mothers. In the first selection of mother beets, as has been stated in previous reports, the general appearance of the beet only is considered. A plat of beets having been harvested, a skilled workman is assigned to the task of collecting those which seem to be

especially fitted for the purpose of producing seed during the coming year. Beets are selected that are perfect in form, with long and tapering tap roots, smooth exterior, and about one pound in weight. These beets are collected, care being taken not to bruise them, and they are at once placed in moist earth until the time comes for siloing for the winter. The tops of these beets which are to be preserved for growing are cut in such a way as not to interfere with the buds at the neck, a part of the stem of the leaf being left on the beet.

SILOING SUGAR BEETS—RESULTS.

The siloing of the beets should not be undertaken until late in the fall, when it becomes necessary to protect them from injury by frost. It is highly important that the temperature of the silo do not rise at any time above 45° F. A higher temperature than this induces growth and a consequent loss of saccharine content.

ARRANGEMENT OF THE SILO.

The beets preserved over the winter at the station were siloed in the following way: They were placed in the silos in a diagonal position, with the tops upward and carefully packed with moist sand. The silos were so arranged as to be easily ventilated. In the bottom of each silo, at the time the beets were placed therein, was placed a half ton of ice, in large pieces, for the purpose of rapidly cooling the temperature of the silo below the growth point. The drainage of the silo was so arranged that the water from the melting ice would not touch the beets. At the closing of the silos on the 5th of November the temperature, as indicated by thermometrical observations, was 43° F.; on the 20th of December the temperature was 42° F., and on the 21st of March, the date at which the silos were opened, the temperature was 39·2° F. These observations show how uniform the temperature of the silos was kept, and at such a point as to prevent to the largest extent any evaporation from the beets or any growth thereof.

The total number of beets placed in the silos was 6,378. When the silos were opened on the 21st of March, the beets were found to be in excellent condition; there had been in point of fact an increase of weight, rather than a loss. This was determined by placing in each silo a given number of carefully weighed beets. These same beets on the opening of the silo were taken out and at once reweighed. Any change in weight would of course be revealed by this duplicate weighing.

INCREASED WEIGHT OF SILOED BEETS.

An illustration of the increase in weight mentioned is given by the following experiment:

The weight of ten beets siloed on the 4th of November, 1892, was 4,840 grams. The weight of this same lot of beets on the 27th of March, when they were removed from the silo, was 5,400 grams—increase 560 grams, or 11·6 per cent. This increase was due to the fact that at the time of siloing the beets they had become wilted from excessive drought. The autumn at the station had been particularly dry, and the beets at the time of harvest were in a partly wilted state. These beets, being carefully packed in moist sand and kept at a low temperature, absorbed moisture during the winter, with the increase of weight noticed. Ordinarily there would be a decrease of weight in siloed

beets, but in the present conditions the reverse was true. Of the 6,378 beets which were siloed in November, 1892, 6,370 were found in perfect condition when the silos were opened, only 8 beets having been spoiled. This is a most remarkable showing, and indicates the care with which the siloing was done.

ANALYSES FOR DETERMINING SUGAR CONTENT.

The mother beets, when taken from the silos, are subjected to analysis in the manner described in previous reports. Each beet, after weighing, is turned over to the analyst, who, by means of a proper machine, removes a cylindrical section diagonally through the beet, thus securing a sufficient quantity for analysis without in any way injuring the beet for germinating purposes. The beet pulp thus secured is subjected to pressure and the juice obtained is analyzed. Inasmuch as the average marc or fibrous portion of the beet pulp amounts to about 5 per cent, the percentage of sugar in the beet is easily calculated by multiplying by ·95 the percentage found in the juice expressed.

The beets were divided by analysis into three classes: The first class included all those beets containing not less than 12 per cent nor more than 15 per cent of sugar; the second class, those beets which contained from 15 to 18 per cent of sugar, and the third or *élite* class, those beets having over 18 per cent of sugar. The number of beets falling into each classification as a result of the analysis of each variety is found in the following table:

Varieties.	No. 1 grade: Sucrose 18 per cent and upwards.	No. 2 grade: Sucrose 15 to 18 per cent.	No. 3 grade: Sucrose 12 to 15 per cent.
Original Kleinwanzlebener	36	465	448
Dippe's	6	483	1,176
Vilmorin's Improved	8	600	784
Lemaire	....	....	476
Desprez	....	....	168
Elite Kleinwanzlebener	7	210	224
Total	57	1,758	3,276

These percentages of sugar were determined by taking the analytical data obtained and calculating therefrom the content of sugar which the beets had at the time of harvest. The data for this calculation included the analyses at the time of havest, at the time of storage, and at the time of opening the silo. As a result of the analyses, 5,091 beets were accepted for the production of seed and 1,179 beets rejected.

Although the conditions of storage, as indicated above, were the most favorable, yet it must not be forgotten that the vital action of the beet in the silo is not altogether destroyed, but only reduced to a certain minimum. As long as the beet is alive there must be still some action of vitality, and this can depend only upon the consumption of the store of plant food which has been accumulated in the beet itself. Therefore, even in the favorable circumstances in which the beets were placed, and at a temperature of, say, 40° F., there was during the period of the storage sufficient vital action to diminish to a certain extent the total percentage of sugar in the beets. This was determined by analysis of average samples of beets at the time of storage and at the opening of the silos. Making correction for the increase in weight due

to the absorption of moisture during the winter, it was found that the average content of sugar in the beets of all varieties at the time of storage was 12, the average at the time of opening the silos had been reduced to 11·6, showing a loss of ·4 per cent of sugar during the winter.

Some of the varieties lost more sugar than others. For instance, in Vilmorin's Improved there was apparently a gain of 0·1 per cent of sugar during the winter, while in the Desprez variety the content of sugar had not changed, nor had it appreciably changed in the Elite Kleinwanzlebener variety.

At the time of the harvest of the beets, on the 10th of October, the average content of sugar therein was 15·1; at the time of their storage in silos it was 12, and at the time of opening in the spring it was 11·6 per cent. There had been, therefore, a total loss of sugar from the time of harvest of 3·5 points. This gave a total loss of sugar from the time of harvest to the time of analysis of 23 per cent, of which 20 per cent, in round numbers, occurred between the 15th of October and the 4th of November (the time the beets were placed in silo), and 3 per cent, in round numbers, from the time they were placed in the silo until their analysis in the latter part of March.

THE PRODUCTION OF SEED.

After the analysis and classification of the mother beets the planting was accomplished by setting them in ground which had been properly prepared. Planting was commenced on the 28th of April and completed on the 2d of May, the different grades being carefully separated in the plats. Special care was taken in this respect in regard to the No. 1 grade (the highest grade), so that it could be sufficiently distant from all other varieties to prevent any contamination by the distribution of the pollen in the fertilization of the seed. Of the 5,091 mother beets which were planted, less than 20 failed to grow, showing a remarkable vitality.

The weather during June was abnormally dry, with a high temperature; but this dry weather did not seem to affect the growth or stand of the plant. There was also another season of dry weather during the latter part of July and the first of August, the temperature being very high, causing the seed to mature somewhat early and thus reducing the quantity of yield. The quality of the seed, however, as indicated by its brightness and weight, was most excellent.

YIELD AND QUALITY OF SEED.

The following data give an idea of the amount of seed obtained in comparison with the yield of seed during the season of 1892. In that year the area planted to mother beets was 98·3 square rods, and the weight of seed obtained 595 pounds, giving a yield per acre of 968 pounds. In 1893 the area planted to mother beets was 113 square rods, and the weight of seed obtained 610 pounds, giving a yield per acre of 863 pounds.

On account of the high quality of the seed it was sold to the Oxnard Beet Sugar Company at a price far in excess of that paid for the best imported seed. The sum received for the seed was at the rate of $172.60 per acre. In regard to the sale of the seed, reference is made exclusively to the seed of the lowest grade. The high-bred seeds of grades No. 1 and No. 2 were reserved for use in experimental work.

COST OF PRODUCING BEET SEEDS.

The general result of the two seasons' experimentation in the production of seed is of the most satisfactory character. It has been shown that seed of the finest quality can be produced, and the germination of the home-grown seed has shown its high vitality. The fact that a practical beet-sugar manufacturer was willing to pay from 5 to 7 cents more per pound for the lowest or third grade of seed than he would for the best imported seed, shows in what esteem this seed was held for practical purposes. It is demonstrated that by proper care beet seed can be produced in this country on one acre of ground planted thereto of a value of at least $150. The actual cost of the production of this seed can not be inferred from the cost of its production in the small way in which it was grown. The extreme care exercised in preventing the varieties from mixing, making it necessary to plant in small plats at great distances, and the extra care and labor which such supervision required, would, of course, increase the cost greatly beyond that which would be incurred in the production of seed in a purely commercial way. The great point which has been demonstrated by these experiments is the fact that seed can be produced of the value of at least $150 per acre; that this seed is bright and clean and of high germinating power, and, as will be seen further on, will produce a better crop of beets for sugar-making purposes than the best imported varieties.

It remains for future experimental work to develop to the fullest extent the soil, climate, and cultural conditions affecting the acclimatization of the high-bred sugar beet of Europe to the conditions obtaining in this country.

EXPERIMENTS IN BEET CULTURE.

The preparation of the plats for planting was commenced in the autumn of 1892. Each plat was thoroughly plowed and subsoiled to the depth of 18 inches in October and the surface of each plat placed in proper tilth. The spring of 1893 found the ground in excellent condition, the surface having been thoroughly pulverized by the frost. The soil, however, in the spring was not thoroughly saturated with water on account of the extremely dry autumn and the failure of the winter's snows to furnish sufficient moisture on melting to thoroughly saturate the undersoil. This did not apply particularly to the surface of the soil, which was moist enough, but to the water reserve below the subsoil, and upon which the subsoil and the soil would be compelled to draw in case of another dry season. The preparation of the plats for planting was finished in April, and the seed, both of foreign and domestic production, was thoroughly tested in regard to its vitality. The planting commenced on the 10th of April and continued at intervals for six weeks.

Careful observations in regard to the germination of the seed showed that, as a rule, the home-grown seed appeared above ground from one to two days in advance of the corresponding imported varieties. In all cases, in order to secure proper tests, the home-grown and imported seeds were planted side by side, not only at the first but at all subsequent plantings.

On April 22 the temperature fell to 13° F., and this winter temperature put a decided check to the operations of the station and of necessity injured greatly the plantings which had been made previous thereto. By reason of this abnormally cold weather the close of April found

vegetation in rather a discouraging condition. For the sake of economy only 5 acres were planted in beets in the spring of 1893 instead of 8 acres, which was the originally intended area for the proper rotation of the station crops. In spite of these discouraging circumstances, however, all the plats presented an even appearance by the beginning of June. On the 7th of June a great dust storm swept over the district. The wind came up from the southwest at 4:30 p. m., and at 5 o'clock nearly every young beet plant had been cut off close to the ground. Only one acre of the total area planted escaped total destruction, and this was so badly damaged in places that the aftergrowth was very slow and the final crop the poorest on the station. The most serious result of this storm, together with another one which came on the 9th of June, was the total destruction of the plants which had been started from the first or highest grade of home-grown seed. The comparative tests were therefore made with the second grade of seed instead of the highest.

All the plats injured were replanted by the 15th of June. The rate of germination of the seed planted at this period was quite in contrast with that of the earlier plantings. The plants from the home-grown seed were visible above ground in 72 hours, while those of the imported seed were first visible after 124 hours, being a conclusive proof of the superior vitality of the home-grown seed.

The cultivation of the plats was more satisfactory than that of any previous years because the laborers employed were the same who had been employed in previous years, and their acquaintance with the methods of beet culture was therefore more thorough.

The meteorological conditions for the growing season are summarized in the following table:

Observations.	May.	June.	July.	August.	September.
	Degrees F.	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*
Mean temperature 1893	58·4	72·2	75	70·7	65·1
Mean for 1892	55·3	66·6	75	72·8	66·5
Mean for 1891	59	68·4	69·9	70·2	65·1
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
Rainfall 1893	4·27	1·64	4·69	2·61	2·03
Rainfall 1892	6·62	·50	2·50	3·36	·28
Rainfall 1891	1·38	11·59	6·71	2·22	·84

Fortunately the insect ravages which produced such disastrous effects on the crop of 1892 were entirely absent during the season of 1893. The cultivation of the crop and its laying by followed in due order, and on the 4th of September the first of the analytical work in the examination of the new crop was commenced.

ANALYTICAL DATA.

As a result of the first series of examinations in the beginning of September it was found that the home-grown seed had produced a greater weight of beets per acre, while they had the full equivalent of sugar content. Compared with the crop of 1892 the data are as follows:

The mean weight of all varieties of beets in 1892 in the beginning of September was 279 grams and the sugar content 10·6 per cent. At the same season in 1893 the mean weight of the beets was 389 grams and the mean sugar content 11·6 per cent. It is thus seen that in both the weight of the beet and the content of sugar the crop of 1893 at this season was superior to that of 1892.

On September 28, as determined by experiment, the mean weight of all home-grown varieties per acre was 13·5 tons, containing 15·8 per cent of sugar, or 4,266 pounds per acre. The mean weight of the imported varieties per acre was 13·3 tons, containing 15 per cent of sugar, or 3,990 pounds per acre.

The data given above were obtained upon beets planted during April and May. It may be of interest to compare these data with those obtained from beets planted later. The beets on which the following observations were made were planted on the 12th of June and on the ground where the previous early planting had been destroyed by the windstorms. This planting, as has already been mentioned, germinated in an unusually short time, and the subsequent growth was rapid and uninterrupted. As perfect cultivation as possible was given to the crop, and the surface of the soil was kept in good tilth during the entire growing season. On the 1st of September the plats presented a splendid appearance, although the beets were far from mature. After the 1st of September the extremely hot and dry weather began to affect the late-planted beets, and it was observed that they were ceasing to increase in weight. Small plats were subjected to irrigation in order to determine whether any difference would be observed between the irrigated and non-irrigated beets. At the time of the harvest of the beets, a month later, it was observed that the surface irrigation had not penetrated to a depth of more than 6 inches, and below that depth the soil was dry and hard.

The late-planted plats were examined analytically only once, and, as each variety did not contain more than a few hundred beets, most of which it was desirable to keep for seed, it was not thought wise to take a large number for examination nor to repeat the analytical work. A time for analysis was therefore selected when it was supposed the beets had approximately reached their maximum of value in weight and sugar content. The results obtained for the different varieties were extremely flattering. The highest sugar content was found with the Elite Kleinwanzlebener, namely, 16·4 per cent, with a purity of 81·6; and all the other varieties approximated closely these figures, except in one instance. The varieties were all grown from domestic seed produced upon the station. The weight of the beets, however, was rather low, being only about two-thirds of the normal weight of a perfect sugar beet, showing that the excessively dry weather of September had prevented them from attaining full growth. The weight per acre and the sugar per acre of each of the late-planted plats are given in the following table:

Table showing yield per acre of sugar derived from different varieties of beets.

[H, domestic; I, imported seed.]

Varieties.	Seed.	Date.	Weight per square rod.	Weight per acre.	Sucrose in the beet.	Sugar per acre.
			Pounds.	*Tons.*	*Per cent.*	*Pounds.*
Elite Kleinwanzlebener	H	Sept. 28	172	13·7	16·4	4,494
Vilmorin's improved	H	...do	150	12·0	16·3	3,912
Dippe's Kleinwanzlebener	H	...do	161	12·8	15·4	3,942
Lemaire	H	...do	178	14·2	15·3	4,345
Knauer	H	...do	190	15·2	16·3	4,955
Desprez	H	...do	178	14·2	15·2	4,316
Original Kleinwanzlebener	I	...do	143	11·4	16.0	3,648
Lemaire	I	...do	190	15·2	14.0	4,256
Mean of varieties from home-grown seed				13·5	15·8	4,266
Mean of varieties from imported seed				13·3	15.0	3,990

Two of these experiments were also duplicated with imported seed, namely, those marked I in the table above. The low yield per acre was without doubt due to the severe drought.

There was an appreciable increase in the yield per acre of the irrigated plats without any appreciable decrease in the content of sugar. The mean yield per acre of the irrigated beets was 16·2 tons, the mean percentage of sugar in the beets 15·3, and the mean yield of sugar per acre 4,957 pounds. The irrigation, therefore, had increased the yield of sugar per acre, in round numbers, 700 pounds.

THE GROWTH OF BEETS AT DIFFERENT ALTITUDES.

A series of experiments was also made in connection with the work at the station in growing beets on the bottom lands of the Platte River. Heretofore it has been considered impracticable to grow beets on this soil, subject as it is to overflow in the spring and being of an extremely sandy nature. The level of the surface of this soil is very little above that of the river, hence the water line through the greater part of the year is very near the surface of the soil. These lands, of course, would be expected to produce a good showing only during an excessively dry year, as during the season of 1893. The spring of 1893 being immoderately dry allowed the lowlands to be worked and beets to be planted early in May. The germination was rapid and the beets grew without hindrance up to the time of maturity.

On September 23 the beets were analyzed, as were at the same time a similar number of beets grown by the same farmer, in the same manner and from the same seed, but upon dry soil lying higher. The comparison of the two harvests is shown by the following data: Grown on the lowland—mean weight of beets, 523 grams; mean percentage of sugar, 13·5; mean purity, 82·8. Grown on the dry upland—mean weight of beets, 381 grams; mean percentage of sugar, 11; mean purity 68·3. In this instance it is seen that the difference is wholly in favor of the beets grown upon the lowlands. The uncertainty of the possibility of the cultivation of these lands, however, in the spring makes this experiment only a matter of interest in showing the necessity for a moderate supply of moisture during the growing season.

The table-lands of Nebraska are not capable of supplying a definite amount of moisture from the subsoil to a growing crop, especially to one which requires so much water for its nourishment as the sugar beet. In this respect they are quite different from the lands of the Chino valley, California, in which crops of beets are often grown, receiving their water solely from subterranean sources. The practical lesson learned from this experiment does not indicate the continuous utility of the bottom lands of the Platte for beet-growing, but the necessity of a deeper and more thorough working of the subsoils of the uplands in order to increase the store and availability of the capillary water of the soil. Nevertheless, in this connection it may be well to speak of the fact that the Standard Cattle Feeding Company, of Ames, Nebr., planted during the last year about 500 acres of beets on what is practically bottom lands. The yield obtained per acre was quite satisfactory, and the content of sugar was also high. It is to be regretted that the officers of the company are not willing to have the data published in detail, but we are permitted to say that the results of the experiment were satisfactory both from an agricultural point of view and financially, the beets having been delivered to a factory and a fair profit realized therefrom.

UNFAVORABLE CLIMATIC CONDITIONS OF NEBRASKA.

The climatic conditions which have attended the three years experiments which have been conducted at Schuyler lead to the conclusion that the climate of Nebraska, in respect to its variations in temperature and rainfall, is not well suited to the production of uniform crops of sugar beets. The variations in temperature are phenomenal. Even during the summer very cold and very hot days may occur in quick succession. The variations in rainfall, moreover, are no less marked. At one time of the year excessive precipitation is likely to occur, followed naturally by excessive drought. All of these excesses of climate are without doubt injurious to the growth of a plant which has been developed under such even conditions as have characterized the growth of the sugar beet in Europe during the past seventy-five years. The plain deduction from these data is that the sugar beet, especially in such a climate as that of Nebraska, will have to undergo some changes, due to the effect of its environment, before it can accommodate itself perfectly to such changed conditions. Even after only two years of growth in the conditions there obtaining the domestic beet shows undoubted marks of superiority to the imported.

One encouraging feature of the problem, however, is found in the fact that in spite of these great variations in temperature and precipitation, and in spite of the fact that, with the exception of one year, we have heretofore had practically nothing but imported seeds for the production of the plants, yet we have been able to produce in three seasons, differing very widely in climatic conditions, crops of beets fairly satisfactory in both yield per acre and sugar content. This result shows that with the highest skill in agriculture a locality, even with such a variable climate as Nebraska, may be made in one sense practically independent of these excesses of seasonal changes.

SPECIAL EXPERIMENTS.

In addition to the general experiments which have been outlined above a number of special experiments in the production of sugar beets was also carried on at the Schuyler station as has been the custom in previous years. These experiments will be found more properly in the special bulletin (No. 39) on the subject of beet culture which has been issued by the Department.

GENERAL CONSIDERATIONS.

So many letters are addressed to the Department of Agriculture making inquiry in regard to the prospects of the beet-sugar industry in the United States that it seems proper to say a few words here on this subject.

The cultivation of the sugar beet is a style of agriculture so strange to American farmers as to require specific instruction and experience in order to successfully accomplish it. For this reason it is not difficult to foresee that any attempt by American farmers to plunge at once into intensive beet culture until they have learned its principles and practice must end disastrously. The great obstacle to the spread of the beet-sugar industry in the United States is without doubt an agricultural one. The experiments which have been conducted by the Department at Schuyler and the results of an immense amount of work done at the various agricultural experiment stations in the different States,

together with the practical work accomplished by the seven active beet-sugar factories in the United States, have demonstrated beyond any possible doubt the fact that beets of a reasonably high sugar content can be produced over wide areas and in quantities approximating those produced in the beet fields of Europe. In so far as the manufacturing is concerned, conditions are practically identical, although it must be admitted that in some parts of this country they are more favorable and in others less so than in Europe. As an instance of more favorable conditions, the experience of California may be cited. On account of the mild winters in that locality it is not found necessary in any case to silo the beets, and unless exposed to the danger of second growth they can be allowed to remain in the ground until the time for manufacture arrives. There is thus a considerable diminution of the expense of manufacture, an expense which comes from the labor of harvesting and siloing the beets and protecting them from frost.

On the other hand, the conditions in Nebraska are distinctly less favorable for manufacture than in Europe. In the climate of the former the access of winter is often sudden and early. It is not unusual for the thermometer to reach the zero point in November. It therefore becomes absolutely necessary that the harvest of the beets should be fully accomplished not later than perhaps the 20th or 25th of October. The whole excess of beets not manufactured at that time must therefore be preserved, and this preservation is an expensive operation in a climate where so severe a degree of frost must be expected. Then, again, the periods of cold may be separated by periods of great warmth. In this case another danger arises: the high temperature which the silos may attain at those times induces growth, or, if the buds making the growth possible are all removed, at least deterioration. Taking all parts of the country together, it may be said that the conditions of manufacture, including the abundance of fuel and its cheapness and the other factors active in determining the cost of production, are as favorable as in Europe. There is one exception to this, of course, and that is in the matter of labor, the cost of which in this country is double, sometimes triple, that paid in Europe for similar service.

During the past year 45,000,000 pounds of beet sugar have been produced in the United States.

EXPERIMENTS IN THE IMPROVEMENT OF SORGHUM AS A SUGAR-PRODUCING PLANT.

The experiments in the improvement of sorghum as a sugar-producing plant were continued at Medicine Lodge, Kans., during the season of 1893.

AN INSECT VISITATION.

A series of misfortunes attended the cultural work at this station. The first planting was entirely destroyed by chinch bugs during the early part of June, so that by the 15th there was nothing left of the first planting except one plat. The invasion of the chinch bug is largely due to the practice of rotating the crops of sorghum with other cereal crops in which the chinch bugs easily breed. It is therefore deemed advisable in future experiments of this kind to use other crops in the rotation. Root crops, vines, or, if possible, alfalfa, where it can be grown, would prove superior to the cereals as rotating crops.

TEMPERATURE AND RAINFALL.

The season as a whole was the driest which has occurred in that part of Kansas in a great many years. The spring was exceedingly hot and dry, and there was no rainfall during the whole of the months of March and April and very light showers in May. The planting time was preceded by eighty days of hot, dry weather, with high winds and not a drop of rain. During the latter part of May there was an abundant rainfall, amounting to 2.18 inches, but it fell at such intervals as to prevent its penetrating the soil to any great depth. During June 1.21 inches of rain fell, and this also in light, scattered showers. The month was very hot, with hot winds on several days. During July 1.44 inches of rain fell. The temperature during the whole of July was exceedingly high, with hot winds. During August 2.25 inches of rain fell, but the weather was exceedingly hot and there was a series of hot winds. The thermometer during this month frequently registered 100° F. in the shade. The rain also fell in light showers. During September 3.40 inches of rain fell, and this was the first time since planting that the land was wet to a depth of 4 inches. As a result, about the only growth the cane made was during the month of September. In October there was scarcely any rain—only .14 inch. A light frost was observed on the 3d and 5th, but no damage was done; on the 8th, however, the frost was severe enough to kill the leaves of the cane. Cane which was planted early in April did not come up until May on account of the ground being too dry to germinate the seed.

CULTURAL WORK.

The character of the preparation of the soil and its cultivation was the same as in previous years. The planting was done upon the plats of the station as usual, and several farmers residing in the vicinity of Medicine Lodge were also employed to grow plats of one acre each on the conditions of previous years, viz, that the plats should be at least 300 yards from any other crop, such as broom corn, the pollen of which could possibly influence the seed. These precautions are necessary in order to secure the varieties in a pure and uncrossed form.

In spite of the fact that the cane scarcely grew at all during the summer, that the whole of the growth was made during the month of September, and that the frosts were exceedingly early, a fair crop was obtained on most plats and with sufficient maturity before the frosts to secure seed selection. The result, however, would naturally be a depression of the content of sucrose in the cane and thus apparently show a deterioration during the year. This deterioration must be considered to be only apparent, however, inasmuch as the good qualities which have been secured by a long series of selections are still contained in the seed, although the actual content of sugar of the stalks bearing the seed for the present season has fallen far below that of some of the previous years. It is not to be doubted, however, that the canes produced by these seeds, under favorable climatic conditions, will continue to show the permanent improvement which has been secured by the processes of selection.

It is proper to state that on the appearance of the chinch bugs in the fields they were treated with the infected bugs which have proved so valuable as destructive agents to the chinch bugs in Kansas, and as a result one plat was saved from destruction.

COMPARISON OF DIFFERENT VARIETIES OF CANES.

The work of seed selection and the chemical work on the station were begun on the 4th of September, ten days later than usual. The comparison of the average of the varieties with the same varieties of last year almost uniformly shows a deterioration in the content of sucrose, and in many instances a very great deterioration in the purity of the juices. The average quality of the canes for the two years and of the different varieties is shown in the subjoined table:

Average quality of leading varieties of cane in 1892 and 1893.

Variety.	1892.		1893.	
	Sucrose.	Purity.	Sucrose.	Purity.
	Per cent.		*Per cent.*	
Collier	18·99	77·13	15·40	72·70
McLean	18·42	77·99	15·20	77·20
Link Crosses	18·36	77·04	16·42	75·50
No. 112	17·20	75·00	15·80	69·60
Link	17·05	74·09	14·30	73·30
No. 8X	16·75	75·40	14·80	77·69
No. 161	16·56	76·00	16·64	60·00
Colman	15·79	72·10	15·54	74·60
Folger	15·53	72·20	15·40	68·14

SELECTION OF SEED CANES.

By reason of the limitation placed upon the money which was to be expended at the station the amount of work undertaken was far less than that of previous years. As an illustration of this the number of seed selections may be instanced. During the season 14,956 selections of seed for propagation were made, against 49,912 last year. The number of seed heads of each of the standard varieties selected during the past season is as follows:

	Number.		Number.
Amber	1,100	Orange	1,597
Folger	2,964	No. 112	1,757
McLean	345	No. 161	151
Colman	868	No. 8X	478
Link	260	Collier	5,441

To those who have not followed closely the work of the Department in the improvement of sorghum by the selection of seed of canes having high sugar qualities, it may not be void of interest to give in tabular form a statement of the number of analyses which has been made for this purpose. Beginning with the year 1888, when the first selections of seed on scientific principles were made, the number of seed selections made in each year for the different standard varieties can be seen from the following table:

Number of seed selections made for different standard varieties of cane during the six years 1888–'93.

Variety.	1888.	1889.	1890.	1891.	1892.	1893.	Six years.
Amber	10	25	12	964	4,319	1,100	6,430
Folger	10	23	32	5,479	13,722	2,964	22,230
Colman	....	22	44	2,236	15,326	868	18,496
Collier	4	17	18	3,077	10,822	5,441	19,379
McLean	....	....	12	4,730	5,904	345	10,991
Link	25	62	147	124	5,310	260	5,928
No. 8	....	....	....	255	2,223	473	2,951
No. 112	....	7	20	220	1,621	1,757	3,625
No. 161	....	18	38	551	1,669	151	2,427
Orange	12	24	5	306	742	1,597	2,686
Various	2,058	13,956	14,668	11,364	28,287	....	70,333
Total	2,119	14,154	14,996	29,306	89,945	14,956	165,476

It is not necessary to call attention to the fact that the number of selections made was far inferior to the number of analyses. Only an approximate estimate can be made of the number of juices examined for seed selections, but it may be safely stated that only about 1 in each 3 was found of sufficient value in its preliminary analysis to warrant its selection as seed. If, therefore, the numbers given in the table are multiplied by 3 it will approximately give the total number of individual canes examined in this work. It is true that the skilled eye can and does select from the standing canes only those which seem likely to have the highest qualities; therefore the number of seed heads rejected by analysis is far less than would occur if the whole number of stalks of cane as they stand in the field were subjected to examination.

THE FUTURE OF THE SORGHUM INDUSTRY.

There is yet much to be done in the way of scientific selection before we can say that the sorghum cane has reached approximately its maximum of development, and even when it has reached this maximum state of development only the most scientific care in the production of seed as a special branch of sorghum culture will maintain the high grade which has been acquired. It is unfortunate that at the present time the economic production of sugar from sorghum is not sufficiently promising to encourage the investment of private capital in a work so absolutely necessary to secure success. With the cessation of the activity of the Department of Agriculture in this direction, dependence must be placed upon the interest which the different States may take in the matter for the continuance of this work. Not only should the method of selection which has been practiced by the Department be continued, but in addition to this, efforts should be made toward the improvement of the cane by intensive culture. So far we have relied solely upon the accidental variations of the plant as caused by the environment to produce those qualities which we desired to preserve by selection. No systematic attempt has been made to provide an environment for the special purpose of stimulating the plant to development in a given direction. The great and powerful forces of varied forms of culture and of different kinds of fertilization have never been brought to bear upon this plant for the purpose of improving it in its sugar-producing qualities. Enough has been done, however, to place the sorghum plant in a position to attract the attention of the capitalist as well as of the scientist.

THE DISPOSAL OF LEFT-OVER SEED HEADS.

The seed heads which bear in their vital principle the effects and results of this long series of experimental work have been distributed as follows: Seed heads of unbroken pedigree have been selected from each variety and preserved for the purpose of continuing the experimental work when thought desirable. Similar seed heads have been sent to those experiment stations which have expressed a willingness to coöperate with the Department in the prosecution of the work of improvement. The rest of the seed has been put up in packages and distributed to those who are likely to take an interest in the growth of sorghum of high sugar-producing power. It is, moreover, very suggestive in respect of other farm crops that these also can be greatly improved in their desirable qualities by the same line of experimental research which has succeeded in bringing out of an unpromising sor-

ghum plant a promising source of sugar. Taking advantage of accidental variations of seed, changes in environment and intensive culture may be able to produce with almost any farm crop improvements in its qualities which will be of interest and value both to the producer and consumer thereof.

EXPERIMENTS AT RUNNYMEDE, FLA.

The experimental work at Runnymede, Fla., during the past year has been continued primarily with the growth of sugar cane and incidentally, as rotation crops, with the growth of garden vegetables, cassava, and tobacco.

CAPABILITY OF PINE LANDS FOR GROWTH OF CANE.

In regard to the sugar cane, the most interesting developments which have been secured are those relating to the capability of the pine lands for the production of sugar. The millions of acres of these lands in the State of Florida where the climate is suited to the growth of sugar cane have heretofore been supposed to have little value for this purpose. The results obtained at our station at Runnymede, however, have led to the belief that these lands are far more valuable for this purpose than has been supposed. It is an interesting fact that although these lands lie only a few feet higher than the peat or muck soils bordering the lakes, yet by reason of their physical characteristics the rate of radiation is so slow during the cool nights that frost is rarely known to attack even the tenderest vegetables on them, while it has often killed similar vegetables in the muck. This statement is also true of sugar cane. While the sugar cane in the muck is frequently frostbitten, and in a few instances has been killed, no such damage has ever been observed on the cane grown on the pine lands. This important observation leads to the belief that the season for the manufacture of sugar from cane grown on these lands can be indefinitely prolonged. It can also be postponed in the winter until such time as the canes have reached their maximum content of sugar. With the muck lands in this part of the State such a postponement would sometimes be attended with danger, although in the muck soils lying 100 miles further south this danger would not exist.

CANE GROWN ON SANDY SOILS.

The best result obtained at Runnymede in the growth of sugar cane has been on the sandy soils mentioned. These soils appear to be pure sand. They do not contain a sufficient amount of vegetable matter to give them the dark color which is found in the hammock lands. They have apparently small quantities of mineral plant food, and yet with only a moderate degree of fertilization with the necessary mineral and organic elements excellent cane is grown, yielding from 10 to 12 tons per acre, and containing, as analyses have shown, as high as 19·5 per cent of sugar. These canes are shorter, stouter, hardier, and harder than the canes grown in the muck soil.

CANE-GROWING IN THE MUCK SOILS.

The result of the experiments in growing cane in the muck soils during the past year has emphasized the fact that the great trouble to be

anticipated in such soils, aside from their deficiency in mineral plant food, is due to deficient drainage. It is clearly demonstrated that in many of these soils the system of open ditches, the only system of drainage so far adopted, is totally inadeqate to secure a proper freeing of the soil from water during the immense precipitation which occurs in that region from May to October. The fields of cane in these soils make excellent growth at first and until the access of the heavy rains and give every promise of a magnificent harvest. After the setting in of the rainy season, however, they begin to diminish in vitality and perish before reaching maturity. It is proposed to try to remedy this trouble, in an experimental way, by pursuing a system of tile drainage, and for the experiments during the coming year a sufficient amount of agricultural tiling has been ordered and placed in position to secure some reliable data in regard to the effect of such drainage upon the growth of the crop.

New varieties of seedling canes have been obtained through the courtesy of the Royal Agricultural Society of British Guiana, and these have been planted on the station at Runnymede, in addition to the other foreign varieties now growing there.

CASSAVA AS A ROTATION CROP.

Experiments with cassava as a rotation crop are still very promising. A large growth of cassava can be obtained per acre upon the sandy soils and even larger growths upon the muck soils. An average crop of 4 tons of roots per acre is not an extravagant statement to make concerning the yield of the pine lands. Experiments, already cited in annual reports, have shown that these roots have over 30 per cent of starch. Starch made from cassava is extremely pure, free from nitrogenous matter, and suitable both for food and for laundry purposes. It is believed that the production of starch can be made a very profitable adjunct to the growth of sugar in all those regions of Florida little exposed to the dangers of frost.

TOBACCO CULTURE—PROSPECTS.

Only a beginning has been made in the culture of tobacco, but it may be said that there is a fair prospect of growing upon these soils a tobacco which in many respects will approach in quality the celebrated Cuban products.

WOOD ANALYSES.

During the past year the Division of Chemistry has done a large amount of work for the Division of Forestry. This work has consisted in the examination of woods for tannin and tanning materials, and in the analysis of sections of pine trees to determine the character and distribution of the resinous bodies which they contain. This work has employed one analyst during almost the whole year, and part of the time two chemists have been engaged in these investigations.

TANNIN AND TANNING MATERIALS.

Some of this work has been of the most interesting kind. Chief among the good results which have been obtained is the investigation of the methods of determining the value of tannin and tanning materials.

As a direct result of the work which has been done, a system of coöperation has been established among the tannin chemists of the country similar in every respect to that secured in the Association of Agricultural Chemists. Samples of hide, powder, and tanning materials have been distributed to chemists from the Division of Chemistry for coöperative work, analysis, and the comparison of the results obtained. Already a uniform provisional system of analysis has been adopted, and it is to be expected that this work will become a part of the investigations of the Association of Official Agricultural Chemists and the chemists engaged therein will coöperate with that body in the further prosecution of the praiseworthy objects in view.

RESINS IN PINE TREES—ANALYSES.

Most interesting results have also been secured in the examination of the distribution of the resinous bodies in pine trees, both those which are unbled and those which have been bled for turpentine. The result of these investigations has been laid before the American Chemical Society and also transmitted to the Division of Forestry for its use.

Another valuable result of the work has been in the elaboration of the methods of analysis, especially in the investigation of a new method of determining the total amount of resin by the precipitation of the abietic acid which it contains as an insoluble copper salt. This process has greatly shortened the analytical methods, and also, it is believed, rendered them more accurate.

FOOD ADULTERATION.

The work of examining canned foods for adulterants and preservatives, to which reference was made in the last annual report, has been extended to complete the examination of canned vegetables. It was not found possible within the year to finish all the work necessary to this examination with all kinds of canned and preserved goods.

ADDED PRESERVATIVES.

With canned vegetables the work has been directed chiefly to the detection of any preservatives which may have been added and to the character of the vessels in which the goods are preserved, and, incidentally, to the food value and digestibility of the contents of the cans.

In the preserving of vegetables if they be subjected to a temperature sufficiently high and prolonged to kill all germs it is found that they are partially disintegrated and rendered less attractive to the eye. For this reason a lower temperature has been employed by some packers for the preservation of the foods, and the subsequent growth of germs which may not have been destroyed by this low temperature has in some instances been prevented by the addition of preservatives, such as salicylic, sulphurous, and boric acids.

Opinions are divided in regard to the wholesomeness or unwholesomeness of these added preservatives, the great weight of testimony being to the effect that while these bodies in small quantities are not injurious to health, yet the continual use of them, even in such small quantities, may finally become prejudicial. It is also shown that the same qualities which enable these preservatives to prevent the action of microörganisms, and thus preserve the food from decay, are also active in the digestive organs and hinder the normal functions of the digestive ferments. In other words, the forces which tend to preserve

in this way the vegetables from decay also tend in like manner to retard the processes of digestion. The fair conclusion is that the use of added preservatives in canned vegetables is objectionable. This conviction, however, is not strong enough to warrant the absolute inhibition of these bodies, but the consumer would be sufficiently protected if the law should require that on each can of preserved vegetables a statement should be found as to the character of the preservative used and the amount of it which has been added. The consumer and his medical adviser are thus properly forewarned of the danger which they may encounter in the way of such foods, and if in the face of this announcement they see fit to continue their use, it is a matter which rests solely with them, and they can not hold the guardians of the public health responsible for any ill effects which may follow. Concisely, the views which we have reached as a result of these investigations are these: First, that the use of added preservatives is, upon the whole, objectionable; second, that their absolute inhibition is not warranted by the facts which have come to our knowledge, but in all cases their presence should be marked upon the label of the can.

THE USE OF COPPER AND ZINC.

There are certain added chemicals which are found in many varieties of canned vegetables which are used not especially for the purpose of preserving them, but for adding to the attractiveness of their appearance. These are chiefly the use of copper and zinc salts to secure and preserve the green color of canned peas, beans, etc. The use of copper for this purpose is a very old one. Long ago it was observed that the cooking of peas, beans, and other green vegetables in imperfectly cleaned copper vessels would secure a deeper and more attractive green appearance for the cooked product. It did not take the observing cook long to discover that this improvement in appearance was due to the copper or zinc present in the copper or brass vessels. The same effect was found to be produced when these vegetables were cooked in ordinary vessels with the use of small quantities of copper or zinc salts. Upon the whole copper salts were found more convenient for this purpose, and hence at the present day an immense industry has grown up in the greening of canned vegetables by the use of copper and zinc, especially of the former, and it is found that a large part of such canned goods exposed for sale in this country has been greened by the addition of copper, and in some cases of zinc. For instance, the amount of copper found in peas of French origin was uniformly much greater than that found in American canned peas. Of 43 samples of American canned peas examined, 32·56 per cent were found to contain no copper, while 67·44 per cent were colored with copper. Of 36 samples of French peas, all were colored with copper except one, which was colored with zinc. In regard to the quantity of copper found, the following comparison will be of interest:

Amount of copper per kilogram.	American peas.	French peas.
	Per cent.	*Per cent.*
Less than 10 milligrams	30·23	0
Between 10 and 18 milligrams	11·63	5·74
Over 18 milligrams	25·58	94·29
Over 25 milligrams	16·28	88·57
Over 50 milligrams	6·98	60
Over 75 milligrams	0	31·43
Over 100 milligrams	0	11·43

The occasional use of a small quantity of a copper or zinc salt, it must be allowed, can be practiced without material injury to health. On the other hand, the continual and regular consumption of even the small quantities of these materials present in canned vegetables must be regarded as at least prejudicial to health. Therefore it is concluded that the public health will be sufficiently conserved, provided each can of vegetables which has been greened artificially in this way shall bear plainly marked upon the label the nature of the greening material and the amount thereof employed. The responsibility for the use of these vegetables will then be thrown upon the consumer, and he can exercise his own judgment with regard to the matter.

The question of the use of copper in canned goods has been agitated in France for nearly a quarter of a century. At first the committees appointed by the Government to investigate the matter reported uniformly against the use of copper for greening. While French packers were not allowed for some time to sell their copper-treated goods to French consumers, they were not prevented from using copper when the goods were intended for export. For instance, in 1875 some Bordeaux packers labeled their goods "Green peas (or beans) greened with sulphate of copper. Made especially for exportation to America and England, and not sold for French use." Copper was present in some of these samples to the extent of 40 milligrams per kilo. After this practice had gone on for some time the board of hygiene of the Gironde concluded to prohibit it, stating that no distinction should be made between goods destined for exportation and those intended for home consumption. Nevertheless, there was such a demand for goods of this kind that the exigencies of commerce gradually got the better of the hygienist, with the result that the French Government has finally permitted the use of copper in greening canned vegetables, requiring, however, that some definite mark shall be used in connection therewith. The canners, however, were shrewd enough to elude the necessity of marking their goods as having been greened with copper or zinc, and fulfill the letter of the law, if not the spirit, by marking them with some indefinite mark such as *à l'anglaise.* The result is that the purchaser of these goods has no intimation, as far as the label is concerned, of the nature of the material which is employed in greening, and the canners themselves claim that if they were compelled to mark their goods as having been greened with copper or zinc it would entirely destroy their sale. The question here is one of sight and not of taste or digestive value, and it seems that it would be wise to recommend to the consumer of canned goods to be content to use them, even if they are slightly pale or yellow, rather than to have them of a bright-green color at the possible expense of health and comfort.

VESSELS USED.

Another prominent feature of the work which we have conducted is found in the examination of the vessels containing the vegetables. In Germany the law requires that the tins employed for holding the canned goods shall not contain more than 1 per cent of lead. In this country there is no restriction whatever in regard to the character of the tin employed, and, as a result of this, the tin of some of the cans has been found to contain as high as 12 per cent of lead. There is no question whatever among physiologists in regard to the effect of lead salts upon the human system. The continual ingestion of even minute quantities of lead into the system is followed eventually by the most serious results. Painters' colic, lead palsy, and other serious diseases well known to physicians are the direct effects of the continual expos-

ure of the system to the influence of minute portions of lead salts. Therefore the greatest care should be exercised in the preparation of canned goods to exclude every possibility of the ingestion of lead. Even tin salts are poisonous, but not to the extent of lead, so that the presence of a minute portion of tin in canned vegetables, coming from the erosion of the cans containing them, is not a matter of such serious import as the presence of lead. Perhaps it would be quite impossible to exclude tin absolutely from canned goods when they are canned in tin, but it is possible to exclude the salts of lead. This can be done by requiring that the tin shall not contain more than, say, 1½ per cent of lead, and, in the second place, that the solder which is employed shall be as free from lead as possible. In Germany the solder employed in sealing the cans is not allowed to contain over 10 per cent of lead, while in this country the analyses of numerous samples of the solder employed show that it contains fully 50 per cent of lead. In addition to this there is no care taken to prevent the solder from coming into contact with the contents of the can. It is not a rare thing in carefully examining the contents of a can to find pellets of solder somewhere therein. Often on examining the inside of a can it is found that large surfaces of solder on the seams are exposed to the action of the acid contents of the can.

Another great source of danger from lead has been disclosed by the analytical work, viz, in the use of glass vessels closed with lead tops or with rubber pads, in which sulphate of lead is found to exist. As a sample of this, the goods of a manufacturer of Bordeaux may be mentioned. All the samples of his goods examined were put up in lead-topped glass bottles. All except one contained salicylic acid, and all of them save one contained copper. In one of these samples lead existed to the enormous amount of 35.2 milligrams per kilo; in another 15.6 milligrams per kilo were found, while in one sample the extraordinary quantity of 46 milligrams per kilo was discovered.

It is not difficult to see how goods covered with lead tops can be contaminated. It may be claimed that these goods should never be turned upside down, but the shippers pay little attention to such directions, and the result is that the goods may be kept for days or even weeks in such a position as to bring the contents of the can into contact with the lead tops or with the rubber pads containing lead. The constant consumer of such goods, therefore, must run some risk of being exposed to the insidious inroads of some of the diseases peculiar to the action of small quantities of lead upon the human organism. It is not too much to ask that the law should require the canners to exercise the utmost care to exclude all dangers of this kind.

The general result of the examination of the canned goods exposed for sale in this country leads to the rather unpleasant conclusion that in some cases the consumers thereof are exposed to greater or less dangers from poisoning from copper, zinc, tin, and lead. These dangers could be easily removed if the manufacturers of these goods were required to follow the dicta of a reasonable regard to public hygiene.

FOOD VALUE AND DIGESTIBILITY OF CANNED GOODS.

In regard to the food value and digestibility of canned goods interesting data have also been obtained. It is hardly necessary to call attention to the fact revealed by the examinations, that some of the canned vegetables, like the same kind of vegetables when green, are more a condiment than a food. This, however, does not constitute any argument for their exclusion.

The fact must not be lost sight of that the human being is not, like other animals, to be fed merely with a view to securing the most rapid development of the body and deposition of fat in proportion to the cost of food consumed. The great difference in the principles of human feeding as compared with cattle-feeding is found in the recognition of the property of taste. Any system of human feeding which rests solely upon the food value of what is consumed or the number of calories which such food will produce when burned is radically wrong. It is true that human beings should have nourishment, but this is only a very small portion of the cost of human food, and from an economical point of view the least important. The palatability of the food, its general attractiveness, its power of giving pleasure and promoting sociability are of more monetary importance in the human dietary than the bare necessity of preserving life. For this reason not only the rich, but even the laboring man in moderate circumstances is warranted in expending a large portion of the amount which he has to devote to the sustenance of himself and his family for those things which, while they may not be very nutritious, are palatable and inviting. The practice, therefore, of preserving vegetables during the season when they are most abundant, and thus providing them in a practically green state when they are least abundant and most expensive, is one which can not be too highly commended.

PURPOSES OF THE INVESTIGATION.

Many of the packers of canned goods have misunderstood the purpose of the investigation which has been made by the Department. There was no intention in this investigation to cast discredit upon any such process. It is true, we considered it our duty to report fully upon all the materials found in canned goods, and which, in our opinion, ought not to have been there, and which were prejudicial to health. We likewise considered it proper to point out the fact, in the special report issued on this subject, that the actual amount of nutritive material in canned goods was wholly disproportionate to the price paid therefor, and that a person purchasing thus an expensive luxury might also be securing a food which contained added bodies prejudicial to health. The object, however, in calling attention to these facts was to impress upon the canners and the public the necessity of preparing canned goods without these objectionable features. In fact, the position taken in the report was of such a conservative nature that it was not deemed advisable to utterly condemn the practice of adding salicylic acid, sulphurous acid, copper, zinc, etc., to canned goods, but simply to ask that in all cases where such additions had been practiced the label should call attention to the fact, leaving the responsibility for any injury which might accrue from the consumption of these goods to rest upon the purchaser and canner in common. In other words, if a consumer of canned goods purchase materials which are known to contain these preservatives and coloring matters, the responsibility rests largely upon himself, and the duty of the Department to the public has been fully discharged in calling attention to the possible dangers which may accrue from the use of these bodies and the necessity for requiring the persons who prepare them to plainly state upon the labels the character of the materials employed.

In the same way the purpose of the special report in calling attention to the enormously high price paid for the nutritive material in canned goods has been misunderstood. There are cases where the resources at the command of the consumer are so limited as to render it neces-

sary for the sustenance of life that he should secure as high a quantity of nutritious material as possible for the sum at his command. In these cases there is no choice left in regard to consulting the taste or the eye. It is a matter of necessity that life should be preserved. In such a case the expenditures for food should rest upon the same ground as in cattle-feeding. By pointing out in the special report the high price of the nutrient in such foods it was intended that this might prove of some advantage to the person temporarily, perhaps, in circumstances which rendered the maintenance of life the first object in the purchase of food. These ideas were incorporated in the special report in the following words:

> A careful perusal of the data in the body of the report will not fail to convince every unbiased person that the use of canned vegetables is, upon the whole, an expensive luxury. It is not the purpose of this investigation to discourage the use of such bodies, but only to secure to the consumer as pure an article as possible. Nevertheless, these practical conclusions may prove of some help to the laboring man and the head of a family, when he finds himself in straightened circumstances, by assisting him in investing his money in a wiser and more economic way than in the purchase of canned vegetables. An expenditure of 10 or 15 cents for a good article of flour or meal will procure as much nutriment for a family as the investment of $3 or $4 in canned goods would.

PROTESTS OF PACKERS.

In many cases where the chemical examination disclosed the presence of preservatives in certain canned foods the packers have protested that a mistake in analysis had been made. It is not necessary to call attention to the fact that chemists are far from infallible, and that mistakes in analysis may be and are frequently made. In matters, however, of this kind extreme care is employed, and where an indication of preservative was found special corroborative tests were made. In all cases of doubt the foods were passed as being without added preservatives. Where, however, the chemical action was plain and unmistakable, there was but one course to pursue in making the report, viz, to state the facts as observed. Numerous protests have been received from packers in regard to this matter, and in many cases additional examinations have been made and in every instance with corroborative results. It is quite possible that imitations of the goods of packers with established reputations have been made by unprincipled parties. One packer acknowledged, in protesting that his goods had been misrepresented by the report, that his firm was in the habit of giving packages of labels to its customers, who complained in some cases that the labels as purchased had been soiled or torn. It is not difficult to surmise that in many such cases these labels may have been affixed to goods of a different quality from those put up by the original packer. In every instance we have been perfectly willing to thoroughly review any contested ground, and are anxious that all packers who feel that their goods have been misrepresented shall have a full and fair review of the work. We shall be only too glad to make any correction in case any mistake shall be found.

It is believed that the effect of the investigations will be of a most salutary kind. Canners will be more careful in the character of the tins which are used in the manufacture, in sterilization, and more particularly in the exclusion of all objectionable preserving reagents. There can be no possible objection, however, to the moderate use of common salt or sugar where the addition will tend either to improve the flavor or the keeping quality of the goods; nor, on the other hand, should there be any objection to the use of copper in greening, as, for instance, with canned peas, if the consumer be plainly informed of the fact.

In regard to the use of salicylic acid and other preservatives of this character, little can be said in addition to what has already been cited. There is a widespread belief among physicians and physiologists that the continued use of salicylic acid, even in small quantities, is injurious. There are some physicians and physiologists, however, who do not share this belief. In a case of doubt of this kind it is safe to go on the prohibition side. There is no doubt of the fact that vegetables can be well preserved without the use of salicylic acid. There is, therefore, no necessity for its employment, and it is hoped that packers in general will exclude it from the list of materials added to their preserved goods.

MISCELLANEOUS WORK.

The miscellaneous work of the division has been in the line of that usually practiced. It would not be profitable to recount here the various analyses which have been made under this head. Numerous samples of waters used for watering stock and for irrigation purposes, minerals supposed to contain phosphates, samples of marls, soils, and occasional samples of minerals containing precious metals have come under this head.

It may be well to state, for the information of those desiring work of this kind, that the Division of Chemistry no longer makes assays of minerals for the precious metals. The only furnaces we have which we could use for the purpose are those employed for incineration in the preparation of ash for analysis. As these incinerations are made in platinum dishes, the use of these furnaces for assays, introducing into them large quantities of oxide of lead, would render them dangerous to dishes of platinum.

It may be well, further, to call attention to the fact that miscellaneous requests for the analysis of fertilizers and soils are uniformly referred to the experimental stations of the States whence the requests come. There are so many local conditions necessary to be taken into account that soil analyses, with the labor and expense necessary, are of little profit when made on samples taken at random and without knowledge of the conditions necessary to make them typical and at a place remote from their location. It is far more profitable and proper that the farmers should apply to their State experiment stations, and not to the Department of Agriculture at Washington, for information of this kind.

The same remarks, to a limited extent, may be applied to the miscellaneous examination of fertilizers. Many of the States now have fertilizer-control laws for the protection of the farmer. Again, local considerations are of the greatest weight in determining the value of a fertilizer in any given case. The actual value for crop-producing purposes of any commercial fertilizer is not determined alone by the percentage of plant food it contains; the character of the soil to which the fertilizer is to be applied has much to do with its value as a crop producer; therefore any information which may be given in a miscellaneous way in regard to the value of a fertilizer can not be taken at its full worth without a knowledge of the character of the soil to which it is to be applied.

It is well again to call attention to the fact that it is not the function of the Division of Chemistry to make analyses of mineral and artesian waters for supposed medicinal qualities. If such waters, however, are to be used for agricultural purposes, they should be referred to the State experiment stations and not to the Department of Agriculture.

REPORT OF THE ENTOMOLOGIST.

SIR: I have the honor to present herewith my annual report as Entomologist for the calendar year 1893. Following the plan of the last report, I have treated in a general way of the work of the division during the year and have added a few short articles upon some of the more important of the insects which have been under investigation.

Very respectfully,

C. V. RILEY,
Entomologist.

Hon. J. STERLING MORTON,
Secretary.

INTRODUCTORY.

The Division of Entomology is brought directly into contact with the farmers and fruit-growers of the country, as it is appealed to in all emergencies where crops are being injured or destroyed by insect agency. For this reason the correspondence has steadily grown during the last eight years, although without any corresponding increase in the appropriations or available force for correspondence. The files of the division show that over 4,000 letters of inquiry have been answered during the year, exclusive of those attended to by circulars printed and mimeographed. In many cases the information sought can be given only upon renewed investigation, as new problems present themselves almost daily during the growing season. The division is also called upon to do a great deal of museum work in the sense of determining species sent in either by farmers or by experiment station experts, as it has come to be looked upon as a center of information in these particulars. Thus, some 10,000 specimens have been examined during the year—a work facilitated by the coöperation of the U. S. National Museum.

The publications of the division during the year have been as follows: Insect Life, Volume V, Nos. 3, 4, and 5, and Volume VI, Nos. 1 and 2; Bulletin No. 28, The More Destructive Locusts of America North of Mexico, by Lawrence Bruner; Bulletin No. 29, Report on the Bollworm of Cotton (*Heliothis armiger* Hübn.), made under the Direction of the Entomologist, by F. W. Mally; Bulletin No. 30, Reports of Observations and Experiments in the Practical Work of the Division, made under the Direction of the Entomologist; Bulletin No. 31, Catalogue of the Exhibit of Economic Entomology at the World's Columbian Exposition, Chicago, Ill., made under the Direction of the Entomologist. These, together with the annual report, make a total of some 800 pages.

The work in apiculture has been unavoidably limited. The apicultural assistant has been occupied for the most part in the preparation of a manual on apiculture, which will soon be completed.

The gypsy moth (*Ocneria dispar*) has come to be well known throughout the country because of the prominence which has been given it in the agricultural literature of the State of Massachusetts. Since 1889, when its injuries to the forests and orchards of certain counties in that State were so serious as to induce the State legislature to appropriate money for its extermination, there has been continued effort to circumvent or exterminate it, and between $300,000 and $400,000 has been voted for the purpose by the State legislature. A committee of well-known entomologists were invited during the year to examine the work of the gypsy moth committee, and reported very favorably thereon. Congressional aid has since been asked for by the State board of agriculture, and the Department has been solicited to further this appeal.

It will be seen, from the report on the San José scale (*Aspidiotus perniciosus*) in Virginia, that this is another case where the spread of an introduced injurious insect has attracted the attention of the State authorities and threatens the fruit interests of the whole Atlantic seaboard. In both these cases the question comes up as to how the division can best assist in exterminating the introduced pest, and it would seem that such cases should be treated in the same spirit in which we would treat a contagious disease of animals that should threaten other sections of the country.

In the case of the San José scale careful investigations have been made by the division, which all indicate that its range is quite limited, and the State board of agriculture appreciates the situation and is ready to do whatever this Department recommends. Before the winter is over, it is hoped we may be able to decide on a course that will effectually stamp it out, even if this should involve the destruction of all trees now affected.

Some space has also been devoted to the consideration of another recently introduced scale-insect from the West Indies, equally to be dreaded, but already in all probability beyond our control. Instances like these are liable to be reported at any time, and the good which the Department may do by the introduction of desirable beneficial species in specific cases, or in the extermination of undesirable species unwittingly introduced into given sections, can scarcely be appreciated by those who have not given the matter thought or who are not familiar with the inestimable good that often has flowed and will yet flow from careful scientific research in this direction.

Considerable time, thought, and labor were bestowed during the year covered by this report upon the preparation and installation of the exhibit of the division at the World's Columbian Exposition, described in detail in the report of Assistant Secretary Willits. The object kept in view in the preparation of this exhibit was to make it thoroughly educational and as far as possible illustrative of the methods employed by the division.

In addition to the ordinary routine work of the division, already indicated, there is certain special work which should be attempted and, if possible, successfully carried out. Such, for example, is the introduction of the Caprifig insect from Smyrna into California. This Caprifig insect (*Blastophaga psenes*) is essential to the proper development of the Smyrna fig, there being between the plant and the insect a relation which is absolutely necessary and mutually beneficial. The action of the insect, which is secured by simple means in Smyrna, gives the

luscious superior quality to the figs of that country which has made them celebrated. The Smyrna fig has been grown in California without the Caprifig insect, and as a consequence is imperfect and can not compete in the markets of the world with the imported figs. The introduction of this desirable insect has been attempted by private parties, and particularly by one public spirited gentleman of Niles, Cal., Mr. J. C. Shinn. These efforts, Mr. Shinn reports, have all, so far, proved fruitless, since the insects, from some cause or other, die either on the way or soon after arrival. The Entomologist regards the matter as of sufficient importance to be taken up by the Department, but much preliminary investigation and arrangement are necessary to insure success.

Again, the bee-keepers of the country have been for some years discussing the desirability of introducing from Ceylon the giant bee of India (*Apis dorsata*) as one which may materially benefit their industry by crossing with our own races of bees. Its introduction seems well worth attempting, and it is respectfully urged that the attempt be made.

Still again, as has been shown in Insect Life (Vol. VI, No. 1), there is a Lepidopterous insect (*Erastria scitula*) in southern Europe which is a formidable enemy of the black scale (*Lecanium oleæ*). This scale is one of the most serious drawbacks to fruit culture, and especially to olive culture, in southern California, and while steps have already been taken by correspondence to introduce the Erastria, it is a case where special efforts are justifiable.

In all cases like these, private effort can rarely be so effectively made as effort by the National Government. Investigations of this kind must be well and carefully planned, and under the direction of specialists who understand what is wanted.

The office force of the division has practically remained unchanged during the year, although Mr. Albert Koebele, a faithful and efficient agent who has been on the force for the past ten years, and since 1886 has been stationed at Alameda, Cal., has found it to his interests to resign and accept a position with the Hawaiian Department of Agriculture and Forestry.*

THE WORK OF THE SEASON.

DESTRUCTIVE LOCUSTS.

Aside from comparatively slight trouble in Minnesota and North Dakota, migratory locusts have done little damage in this country for seventeen years. Several local nonmigratory forms have, however, during the past three years attained exceptional prominence. This is due to a succession of comparatively dry seasons. In 1891 local damage was quite general throughout the so-called Western States, and the division has published somewhat detailed accounts of outbreaks of local species in eastern Colorado, portions of Kansas, Idaho, and Wyoming. During 1892 the damage was less, though nonmigratory species were abundant and somewhat destructive in a number of other localities. During the present season there has again been an increase, and even in many of the Eastern States, where close cultivation and diversified farming afford conditions which, on the whole, are unfavorable to the increase of these insects, they have been so abundant as to

* Since this introduction was written all the field agents have been discontinued.

attract general attention. Accounts have been received of damage from northern Massachusetts, northern New York, western Ontario, central Pennsylvania, northeastern Ohio, northwestern Missouri, eastern Colorado, southern Idaho, and one or two points in California. We have not, however, received a single specimen of the Rocky Mountain or western migratory species (*Caloptenus spretus*) or of the lesser migratory locust (*Caloptenus atlanis*). All the damage has been done by the nonmigratory species. Bulletin 25 of the division, published in June, 1891, has proved of great service in this connection, as it relates almost exclusively to the best remedies for destructive locusts. In nearly every instance where serious damage has been threatened, the recommendations in this bulletin have been followed. Particularly good results were obtained in Colorado and in Kern County, Cal., during the last season. Bulletin 28, in which illustrations and full descriptions of the species of locusts likely to become injurious are given, has also served a good purpose, as it has enabled correspondents of the Department to recognize species occurring in numbers, and this recognition has, in many cases, allayed unnecessary alarm over the supposed advent of the migratory species.

THE WESTERN OR GREAT PLAINS CRICKET.

The western cricket, *Anabrus simplex* (Plate IV, Fig. 3), has, during the season, caused a great deal of consternation over a large area of the middle portion of the Great Snake River plains in Idaho and the mountain region to the north, chiefly along the Wood River and its tributary valleys. In that particular locality the crickets have been known to exist for thirty years or more and to hatch in limited quantities annually. They have never become so numerous, however, as to cause serious damage until the present year. For three years they have been increasing noticeably, each year working farther out upon the valley, and laying their eggs wherever overtaken by fall, until last season the districts extending from the banks of the Snake River to the top of the mountains, 75 miles to the north, were fairly well stocked. They hatched numerously the present spring, and the young were found in considerable numbers even on the top of some of the mountains close to the snow line, at an elevation of not less than 7,000 feet. Some little damage was caused by many thousands of specimens being carried down the Boisé River and finding their way into the irrigating canals, thus being carried out into the cultivated fields. Nearly all these, however, were destroyed before reaching maturity. The Camas Prairie, referred to by Mr. Bruner in Bulletin 27 as having been overrun by *Camnula pellucida*, *Caloptenus atlanis*, *C. fœdus*, *C. bivittatus* and *Pezotettix enigma*, in 1891, seems to have suffered most. The permanent breeding grounds of the crickets seem to lie 20 to 40 miles south of the prairie, and, in migrating, this fertile region was entered in great numbers. In 1891 very few specimens were noticed, in 1892 more, and the present year millions. This interesting migration was investigated by Mr. Robert Milliken, who was temporarily commissioned by the Department for this purpose. He found that eggs were deposited over the entire area overrun, from the Snake River to the mountains, making the outlook for the season of 1894 very gloomy. The cricket swarms travel at the rate of about a mile a day, and a considerable portion of the adjacent territory may be overrun. The reports indicate, however, that at certain points along the south line of the foothills the crickets died off by millions from disease.

The free use of coal oil affords the best remedial treatment for this insect. Where irrigation is practiced it is a comparatively easy matter to protect fields of grain by allowing coal oil to drip from a pail upon the surface of the water running in the ditches. Armies when on the march are easily driven, and some success has been obtained by driving them around the edge of a green field. In fact, the driving of flocks of sheep through a grain field results in stamping many thousands of the crickets to death and in driving the remainder away. The free use of "hopperdozers" soon after the hatching of the eggs is also practicable upon lower lying ground.

THE ORANGE MEALY-WING.

A small insect which affects the leaves of the orange in Florida and Louisiana and in northern greenhouses has been studied for a number of years. It has recently appeared in such great numbers as to cause some alarm among orange-growers, and an extended article upon the species has, therefore, been published in Insect Life (Vol. V, pp. 219–226). The stages of the insect were fully described under the name of *Aleyrodes citri*. The species in all its stages is shown upon Plate III, and a summary of the facts is herewith given.

As a rule, the insects pass the winter in the full-grown larval condition. They change to pupa in the early spring, and the adult insects, which are minute four-winged flies, issue in March and April, and soon begin to lay their eggs. Each female lays probably from 25 to 40 eggs, and these are attached by a short pedicel to the under surface of the leaf. The young soon hatch and stay on the under side of the leaf. They are delicate and nearly transparent, and, therefore, very difficult to observe. In fact, so truly is this the case that the leaves of an orange tree may be swarming with the insects and the owner never suspect the fact.

There are three annual generations in Florida and Louisiana and two in the greenhouses at Washington. Where the attacks of the insect are severe the under sides of the leaves become incrusted with the bodies of the insects, which overlap each other and completely obviate all transpiration from that surface. Moreover, there results from the small quantity of honey dew secreted by the insects an invariable coating of smut fungus, usually most marked on the upper side of the leaf, and the tree is thus deprived of almost its entire leaf surface. We have not learned that any trees have been actually killed by the attacks of this insect, but the health of large numbers has been seriously prejudiced, and there is a great need for the application of an efficient remedy in many groves.

The careful experiments which have been made indicate that kerosene emulsion will kill the insect in all its stages, but that it is more efficacious when applied to the adults and the younger larvæ than when applied to the older larvæ and pupæ. It will destroy the eggs, but when applied to the pupæ many escape, owing to the fact that this stage is passed within the last larval skin. A single spraying will not kill all the eggs, and two or three operations are required to produce this result. Winter spraying against the full-grown larvæ will hardly pay. The best time to spray will be during or just after the flight of the first brood of winged individuals in March and April. Two thorough sprayings, at intervals of two weeks at this time of the year, should reduce the numbers of the insect to such an extent that no further treatment will be needed during the season. The standard emulsion, diluted with ten parts of water, is recommended for this purpose.

THE PERIODICAL CICADA.

During the present year two interesting broods of the periodical cicada (*Cicada septendecim* Linn.) have appeared in different parts of the country. Previous records showed occurrences of these broods as follows:

Brood XVI.—Tredecim—(1880, 1893).

Alabama.—Lowndes County.
Georgia.—Cobb and Cherokee counties.
Tennessee.—Lincoln County.
North Carolina.—Lincoln and Moore counties.

This brood is but little known, and all localities require further confirmation this year.

Brood XI.—Septendecim—(1876, 1893).

North Carolina.—From Raleigh, Wake County, to the northern line of the State; also in the counties of Rowan, Davie, Cabarrus, and Iredell.
Virginia.—From Petersburg, Dinwiddie County, to the northern line of the State; Bedford and Rockbridge counties; Valley of Virginia, from the Potomac River to the Tennessee and North Carolina lines.
District of Columbia.—Woods north of Washington.
Maryland.—Southern half of St. Mary's County.
Kentucky.—Trimble County.
Indiana.—Knox, Sullivan, and Posey counties.
Illinois.—Madison County.
Kansas.—Dickinson and Leavenworth counties.
Colorado.—Cheyenne Canyon.

The past records, however, in the case of a number of the broods of this insect have not been as full and accurate as could be desired, and, moreover, it is most important to trace the exact extent of each brood as it makes its appearance, in order to notice variations induced by the advance of civilization. A circular, giving the localities in which these two broods had been previously noticed and asking for notes, was therefore prepared and mailed early in June to correspondents living within the regions in which it was anticipated that the insect might appear. Copies of this circular were also sent to prominent newspapers published in these regions, with requests to print it and to urge their readers to correspond with the division.

Regarding Brood XVI, concerning which there was little previous information, but one report which might possibly refer to this brood has been received. Mr. Thomas J. Key, of Montgomery, Ala., writes simply: "The cicada is in Montgomery County, Ala., and there were a few here in 1892." This note from Mr. Key, however, was not received until September 9, and it is probable that he refers to the annual, and not to the periodical, species, so that practically we must pass over this brood as unverified this year. That such a brood did exist, however, seems likely from the exact testimony of Dr. Gideon Smith of its appearance in Cherokee County, Ga., in 1828, 1841, 1854, and from Dr. John G. Morris's statement of its appearance in the same locality in 1867.

The replies to the questions concerning Brood XI indicate some interesting facts. The doubtful States were Kansas and Colorado. Concerning the former, reports of the occurrence of the insect have been received, though the dates given justify some doubt as to the species referred to. Mr. James Dunlop, of Detroit, Dickinson County, states that they made their appearance in the beginning of July, and were distributed over the whole county. The Colorado locality remains unverified, although Mr. John Gardiner, of the University of Colorado,

visited both the north and the south Cheyenne canyons during July and made a special search for the insect, but found no trace of it.

From Illinois no verification has been received of the Madison County appearance, but Mr. J. H. Atkinson, of O'Fallon, St. Clair County, reports that it made its appearance in small numbers on July 1, doubtless referring to *C. canicularis*. The insect made an unexpected appearance in two localities in Pennsylvania. This seems to be a northward extension of the Virginia, District of Columbia, and Maryland district. Mr. M. W. Strealy, of Chambersburg, found that they appeared in marked quantities in May and June a mile east of the Franklin-Adams line, extending north and south from Mont Alto, in Franklin County, to Pine Grove, in Cumberland County. These were not necessarily the limits of the appearance, but were simply the limits of Mr. Strealey's journeys. Prof. W. W. Buckhout, of the State College, Center County, found quite abundantly, two or three miles east of Phillipsburg, dead branches containing eggs the second week in August. He also found pupa shells. In Maryland they were reported in the lower part of Prince George County, and in the District of Columbia they were noticed by members of the office force in the woods north of Washington early in June, and also along Rock Creek. In Virginia we have several new localities, which, however, simply corroborate the general distribution of the brood, as indicated in Insect Life (Vol. v, p. 229). That the brood extends across the North Carolina border line is indicated by a notice in the Winston Sentinel of July 12, to the effect that the insect made its appearance at Elkin, in Surry County. This information was kindly transmitted by Mr. William Sharswood, of Boyden, Surry County.

Next year, 1894, two broods will make their appearance. The first, Brood XII, a seventeen-year brood, appearing last in 1877, will occur in northeastern New York and down the Hudson River to its mouth; thence eastward to New Haven and westward across the northern part of New Jersey into Pennsylvania. Isolated patches will occur in Dearborn County, Ind., Kalamazoo, Mich., and in localities in North Carolina, Virginia, and Maryland. Brood XVIII, a thirteen-year brood, is by far the largest of the thirteen-year broods, and one of the best known of all those recorded. It was carefully studied in 1868, and its Missouri and Illinois localities are particularly well established. It will appear in southern Illinois, throughout Missouri (except in the northwestern corner), in Louisiana, Arkansas, Indian Territory, Kentucky, Tennessee, Mississippi, Alabama, Georgia, and North and South Carolina. The occurrences of this brood have been traced further back than those of any other thirteen-year brood, and its South Carolina appearances are known for 1881, 1868, 1855, 1842, 1829, and 1816.

THE HOP PLANT-LOUSE IN THE NORTHWEST.

Up to the year 1889 *Phorodon humuli* had never been found in the extensive hop fields of Oregon and Washington. Just how and just when the species was first introduced it is difficult to state, and no investigations in this direction have been made. Specimens were first sent to the division for identification in 1889, but it is probable that the species was introduced at least a year previous to that date. The most reasonable supposition with regard to the introduction would be that the winter eggs were carried to the coast upon plum cuttings or plum stocks. So far as we know, the winter egg occurs upon no other plant, and it is difficult to imagine any other method of transport. In the year 1890 the insect increased with marvelous rapidity and caused

the loss of about one-fifth of the entire hop crop of Oregon and Washington. This means a money loss of about $870,000 to those two States. Largely on account of this 1890 damage, but also on account of the appearance of the lice in alarming numbers in the hop fields of New York in the first part of June, 1891, an emergency leaflet was published by the division on June 11, 1891, and circulated throughout the three States mentioned. The life history of the insect was briefly reviewed, and remedial treatment by spraying with kerosene emulsions and fish-oil soaps was recommended. Formulæ for the best two mixtures of these classes were given, and the subject of spraying apparatus was considered in some little detail. The damage done by the lice in 1891, however, does not seem to have been as great as in the previous year. A number of hop-growers experimented with the remedies recommended in Circular No. 2, with the result that in a number of instances, through improper preparation of the kerosene emulsion in particular, some damage was done to the vines. These cases were immediately seized upon and exaggerated by persons interested in the sale of quassia chips. Decoctions of quassia chips had been in use in England against the hop plant-louse for some years. They were carefully tested in the field experiments of the division in New York in 1887, and while they were found to be of value, they were found inferior to both fish-oil soaps and the kerosene emulsions, while their cost was greater than either of the others. They are to be recommended only when the treatment has been neglected until the lice are swarming in the burrs.

Certain officers of the State board of horticulture of Washington were impressed by the fact that certain wingless plant-lice were found upon old roots of the hop vines during the winter. The conclusion drawn from this finding was to the effect that the lice occasionally or habitually hibernate upon the roots of the vines, and not, as stated in our writings, in the egg state upon plum trees. Some correspondence ensued, but upon the receipt of specimens we were enabled to set the matter at rest, since, as in a similar case in New York in 1886, the insect found upon the root of the vines proved to have no connection with the hop plant-louse, but to be a species of the wingless genus Tychea. In its discussions with the hop-growers of these two States the division received the warm support of Prof. F. L. Washburn, entomologist to the agricultural experiment station at Corvallis, Oreg., who published several circulars of information and query, based upon results obtained by investigations of the division. The Entomologist planned a trip to the Northwest during the summer of 1892, in order to settle all controverted points and place the hop-growers of these two States in a position to successfully and intelligently fight this destructive insect. Other matters interfered, however, and the work had to be postponed until the present season.

In the meantime Prof. Washburn, as the result of extended correspondence with hop-growers in his own State and in Washington, had gradually come to the conclusion, as evidenced in one of his recently published papers, that, while the kerosene emulsions were efficacious against hop lice, the difficulty of their proper preparation detracted from their availability. Improperly prepared and by ignorant persons, they resulted in the burning of the foliage. It was, therefore, still more important that the hop fields should be visited the present season and by a person familiar with the simple methods of preparing these important insecticides; and as a result, Mr. Koebele was commissioned to visit the fields in June, 1893. The season, unfortunately, was at least

two weeks later than usual, and Mr. Koebele was unable to conduct spraying operations upon any extended scale in the hop fields. However, he made a number of interesting observations and conducted experiments upon a small scale, both upon plum and upon the first generation of the lice which appeared on the hop. The results confirmed in large degree our eastern experience. The entomological points of importance brought out by the investigation are the finding of a new species of Phorodon upon mint, which was confounded by certain Western observers with the true *P. humuli*. The latter was found to feed, as in the East, only upon plum and hop. A number of ladybirds were observed feeding upon the hop plant-louse, and were accurately determined. The insecticide work showed plainly the superiority of both the fish-oil soaps and the kerosene emulsions over the quassia mixtures. Preference was given to the fish-oil soaps, and that mentioned in our emergency Circular No. 2 was found perfectly satisfactory. Too much emphasis can not be laid upon the importance of using the best quality of potash lye. The formula, in brief, is: Potash lye, 1 pound; fish oil, 3 pints; soft water, 2 gallons. The lye is dissolved in the water, and when brought to the boiling point the oil is added, and the batch is boiled about two hours. Enough water is filled in to make up the evaporation by boiling, and the result will be about 25 pounds of soap, which when cold may be cut and handled in cakes. This is enough for 150 gallons of effective wash, and will cost about 23 cents in Oregon.

Recalling his experience with the very effective resin compounds, which he first used against the fluted scale in his experiments as an agent of the division at Los Angeles, Cal., in the summer of 1886, Mr. Koebele undertook a series of experiments with this substance and found it very effective. As the result of his experience, he recommends 1 pound of caustic soda dissolved in 2 gallons of water, and 6 pounds of broken resin to be boiled with about 3 quarts of the resultant lye. After the resin is dissolved, the rest of the lye is to be added slowly, with water to make about 8 gallons of the compound, which should be still further diluted with water before cooling. The resulting mixture should be clear and brown in color, and at this stage it is readily diluted with water. A milky appearance indicates imperfectly saponified resin. Resin is sold at Portland, Oreg., at about $4 per barrel of 280 pounds, and this compound of saponified resin, made according to the above formula, will cost about 17 cents, and will dilute into about 75 gallons of strong wash. If diluted to 100 gallons of wash, it will still be effective upon plant-lice, while the predaceous ladybirds will not be killed by it. The action of the resin upon the plant-lice is said to be immediate. It spreads readily and adheres to the surface of the leaf.

In conclusion, the importance of work in the early part of the season upon plum trees can not be too strongly reiterated. It will be an easy matter to limit the number and size of the plum trees in the vicinity of the hop fields to such a degree that they may be treated with the utmost ease. With care this treatment may be made to forestall any necessity for actual spraying of the hops.

DAMAGE TO FRUIT TREES BY THE RED-LEGGED FLEA-BEETLE.

Early in April word was received from Mr. George E. Murrell, Colemans Falls, Va., to the effect that 1,000 peach, pear, and plum trees had been entirely denuded of blossoms and buds within forty-eight hours

by a flea-beetle, whose attack he had not been able to arrest up to the time of writing. An assistant (Mr. E. A. Schwarz) was, therefore, sent to the spot to investigate. He found that the insect doing the damage was the red-legged flea-beetle (*Crepidodera rufipes* Linn). (Plate IV, Fig. 2). He found the farm situated at the base of a high spur of the Blue Ridge Mountains. Upon a flat-topped ridge, originally covered by a dense growth of shrubbery, composed mainly of black locust, but which had been cleared and plowed in March, the young orchard of 1,000 trees was set out towards the end of March or the first week in April. During the first warm days of the year immense numbers of the flea-beetles appeared and destroyed the blossoms and leaf buds. On April 14 not a single green leaf or living bud was to be seen. The beetles, however, were still numerous upon the trees in spite of several applications of insecticides which had been made by Mr. Murrell between April 8 and 14. The breeding habits of this beetle do not appear to be known, although it is surmised that they live in the larva condition in the roots of black locust (*Robinia pseudacacia*), since this is the favorite food plant of the adult. The insect unquestionably hibernates in the perfect condition. Mr. Murrell unconsciously did the worst thing he could possibly have done in clearing off the scrub in March and immediately plowing and setting out his orchard, as the beetles were thereby disturbed in their hibernating quarters and given an early start with a good supply of food in the shape of the young fruit blossoms. It is hardly supposable that such great damage as this to fruit trees, young or old, from this beetle will recur except under just these conditions. Where land covered with locust scrub is to be put into orchard, it is plain that the scrub should be rooted up in the early summer, the land then plowed and left in fallow until the following spring.

The insecticides which Mr. Murrell applied proved to be of little use. The insects came in increasing numbers, resembling an invasion of rose chafers, and the bare smooth bark of the little saplings offered little hold for the arsenical poisons. The kerosene emulsion killed those which it touched, but others followed immediately afterwards. It was found that jarring the young trees was entirely practicable, and that with the aid of an umbrella a person could capture nearly all the beetles upon a tree at any one time, walking hastily through the orchard and jarring at the rate of 200 trees an hour.

FURTHER BOLLWORM INVESTIGATION.

As has appeared from previous reports, considerable attention has been paid to the bollworm during the past three years on account of Congressional appropriations specifically designated for this purpose. In the course of the investigation of the cotton-worm in the years 1878 to 1882, the bollworm was incidentally studied with great care, and in the Fourth Report of the U. S. Entomological Commission a long chapter was devoted to its habits, life-history, and the remedies to be used against it. Its increasing injuries in the Southwestern States, however, since the publication of this report excited a great deal of interest among cotton-growers, and the supplementary investigation was undertaken largely for the purpose of testing the former conclusions as to the remedies to be used, and to make the general acquaintance with these remedies more widespread. Incidentally experiments were undertaken with certain bollworm diseases, since prominent men in the South had claimed that by their means the rav-

ages of the insect could be checked. As anticipated, the results of the experiments in this direction were negative, and Bulletins 24 and 28 of the division summed up the supplementary investigation.

The original cause of the special appropriation for the continued investigation of this subject was certain theories very strenuously urged by Mr. J. B. Brown, of Utica, Miss., which were not in accordance with the views of competent naturalists. One of these theories, more particularly, was a denial of the specific identity of the bollworm with the corn ear worm. A great deal of correspondence has been had with Mr. Brown during the past three years, and during the last year the Senators from Mississippi were again appealed to and the Department urged to investigate the matter once more. Mr. William H. Ashmead was, therefore, sent to the State, and spent a portion of the summer in carrying on field experiments under Mr. Brown's eyes, with the result that the previous conclusions published by the Entomologist, as well as by other authorities who have written on the subject, were entirely borne out and Mr. Brown himself satisfied of their truth. In short, the life-history of the insect, as given in the Fourth Report of the U. S. Entomological Commission and in Bulletins 24 and 28 of this division, is shown to be strictly accurate and all opposing theories groundless.

JAPANESE INSECTS.

As the commercial relations between this country and Japan are constantly increasing, the danger of importing injurious insects is also on the increase. The extent to which Japanese plants are being brought to this country, largely by florists and for ornamental purposes, is hardly realized by persons not engaged in the business. We have seen the sales catalogue of a San Francisco firm which lists several hundred varieties of flowering and foliage plants, all of which have been imported from Japan within the last few years. While the California inspection and quarantine laws have undoubtedly been of great benefit, yet even Mr. Alexander Craw, one of the most intelligent and efficient of the quarantine officers, admits that the inspection has little of practical value, and we are, therefore, constantly subject to an unknown danger. The insects of Japan are not well known to entomologists, while their species of economic importance have, with almost no exceptions, remained unstudied up to the present time. Aside from the codling moth of the peach, the life history of which has been carefully worked out by Prof. C. Sasaki, we do not recall a single pest of the first importance peculiar to Japan, the habits or even the existence of which is known to economic entomologists. We are far better informed regarding the insects which are liable to be brought to us from every other direction.

During the winter of 1892-'93 an opportunity was offered, through the return to Japan of Mr. Otoji Takahashi, a young Japanese who had made a special study of entomology at Cornell University, to make a preliminary effort to gain some knowledge of the insects of that country injurious to fruit trees. He was, therefore, commissioned as a temporary agent of the division, and has since collected somewhat assiduously and has corresponded extensively with this office. The material which he has sent is all of great interest and is nearly all new. He has devoted his attention principally to scale-insects, and has made an especial effort to collect those occurring upon citrus trees and upon the plants which are being imported into this country. It is gratifying to

find that, upon the whole, insects are not so injurious to crops in Japan as in this country. Whether this is due to climatic and soil conditions or to methods of cultivation it is as yet impossible to decide. The probabilities are, however, that diversified cropping and small farming have much to do with this exemption from insect injury. The insects received and studied will be described elsewhere, and only the most important among them need be mentioned here. They are as follows:

The interesting Cerambycid borers in the trunk of orange, viz, *Apriona rugicollis* and *Melanauster chinensis;* a root louse, probably of the genus Schizoneura, on the roots of orange and pomegranate; two Lepidopterous larvæ, feeding upon the leaves of citrus trees, viz, *Papilio demetrius* and *P. xuthus;* a leaf-miner on orange, belonging to the genus Lithocolletis and resembling in markings *L. cratægella* of this country. Among the scale-insects on orange the most interesting are a new species of Icerya, of which but one mature specimen was received, together with a number of immature individuals; a new species of Ceroplastes and a new species of the true genus Aonidia; a new species of Mytilaspis, seemingly intermediate between *M. gloverii* and *M. citricola,* and a species of Diaspis closely resembling *D. colvei* Targ. There was also a Pulvinaria-like form which may prove, upon receipt of more characteristic material, to be a Lichtensia; this species occurs upon the leaves of orange.

ANOTHER SCALE-INSECT NEWLY IMPORTED INTO CALIFORNIA.

In the last annual report attention was called (p. 157) to the fact that the well-known European olive scale (*Pollinia costæ*) had made its appearance in Los Angeles County, Cal. We have now to record the occurrence of another importation, which may prove to be a very dangerous one. In 1889 Mr. Henry Tryon, of the Queensland Museum, in his Report on Insects and Fungous Diseases, No. 1, described a new Diaspis under the name of *D. amygdali,* calling it the white peach scale. This insect occurs at Brisbane, Queensland, and Sydney, New South Wales. Concerning its appearance he says:

> At first its presence is betrayed by small white spots or patches on the bark of the smaller branches; but as the insect increases these soon become in many places confluent and the individual scales overlap one another and are contorted by being squeezed closely together, or even appear to lie one over the other. As it will occur quite up to the tips of the branches, the complete destruction of any tree subject to the attack of the peach scale, and owing to it, is only a matter of time. When already in patches on the branchlets and prior to the formation of the leaves, and particularly in early spring, it does not hinder their formation; the leaves are green as usual, the fruit sets, but is soon retarded in its growth and shrivels up.

Full descriptions of the different stages, with the exception of the male adult, are given, and the fact is recorded that a Hymenopterous parasite pierces 80 per cent of the scales. The parasite, however, was not found, and its presence was indicated only by its exit holes.

In February, 1893, there were received from Mr. Coquillett at Los Angeles specimens of what is undoubtedly this species, which he found upon a dwarf flowering almond recently imported from Japan. The occurrence of this insect upon a Japanese plant is interesting, and suggests that Japan is probably the original home of the species, and that it was imported from that country into Australia. It is quite likely that, unless steps be taken to destroy it, this scale will obtain a foothold in the peach orchards of California, in which case it may prove a serious matter. This is another case which goes to prove the necessity for a strict quarantine inspection. It is encouraging to note, however,

that a parasite was possibly imported with the scale, as some of those received from Los Angeles showed exit holes.

ANOTHER ENEMY OF THE BLACK SCALE.

Considerable popular attention has been attracted to a recent discovery by Prof. H. Rouzaud, of Montpellier, largely through the announcement made by M. Perrier, of the Paris Museum, to the Academy of Sciences, which has been copied into many newspapers. The discovery is to the effect that a small Noctuid moth (*Erastria scitula* Rambur) feeds in the larval state upon the black scale (*Lecanium oleæ*) and other large Lecaniines. The species was carefully studied by Prof. Rouzaud during the season of 1891-'92, and he has published a very careful and complete résumé of its life-history and habits. It seems that the insect has from five to six generations through the summer, and that its larvæ are very rapacious, each one destroying a large number of the black scale during its growth. The number of individuals of the predatory species decreases toward the close of the season for lack of food, but on account of the number of generations increases rapidly again for three or four generations the following summer. It is an easy species to handle, and M. Rouzaud, in correspondence with the division, offers to send living individuals for practical use in this country.

It may be, as stated in another paragraph of this report, that the Australian *Rhizobius ventralis* will prove perfectly effective as a remedy for the black scale in California, but, in the event of its failure, the Erastria will be a most desirable addition to our insect fauna. Looking at the question from an abstract standpoint, it will be more likely to succeed in exterminating the black scale than will Rhizobius, since the Erastria and the Lecanium are both indigenous to the same regions, and since the black scale is not the pest in south Europe that it is in California and Australia. In California the important Hymenopterous parasite *Dilophogaster californica* (probably originally a Hawaiian insect) has not succeeded in destroying more than a surplus of the black scale, nor has the Rhizobius done more than this in Australia. We have notified M. Rouzaud that we should like to attempt the introduction of the Erastria, and the coming season will probably see it established in this country. It is shown in larval, pupal, and adult states at Fig. 1, Plate IV.

INTRODUCTION OF HESSIAN-FLY PARASITES.

Further facts in regard to the interesting introduction of *Semiotellus nigripes* (= *Entedon epigonus*), a circumstantial account of which was given on pp. 235-237 of the Report for 1891, have not been obtained. As in 1892, our correspondent, Mr. Fred. Enock, of London, who sent us the original lot, has been again unable to collect affected Hessian-fly puparia in numbers, and no living specimens from his first importation have been observed the present season. This, as stated upon page 158 of the last report, does not necessarily mean that the experiment has proved a failure, since, as there stated, the parasite may exist in the field without being discovered, as it is very minute and the numbers liberated were very small in comparison with the numbers of the Hessian fly in a favorable year. Moreover, Prof. Forbes and his assistants have been busily occupied during the entire season in connection with the Chicago Exposition, and no adequate search has been made for the species in the localities where the experiment bade fair to be a success.

WORK OF FIELD AGENTS.

The following brief summary of the work under this head will prove useful in this report:

California.—The agent at Alameda, Mr. A. Koebele, resigned his position under the Department October 1, but has sent in a brief report on the first part of his season's work. His main labors were devoted to the investigation of the hop plant louse (*Phorodon humuli*) in Oregon and Washington, the results of which have been indicated elsewhere in this report, and a full account of which will be found in Insect Life (Vol. VI, pp. 12–17). He has further reported upon a trip to investigate the present condition of the beneficial insects which he sent and brought over from Australia, and this report will also be found in Insect Life (Vol. VI, pp. 26–29). In his short report covering the result of his nine months' work in 1893 he reviews once more his work upon the hop plant-louse, giving additional information concerning the ladybirds which prey upon *Phorodon humuli* in Washington and Oregon, and refers to the damage done to fruit buds in Oregon by *Syneta albida*, an insect which has been already noted in Insect Life (Vol. IV, p. 396). He also speaks of an undetermined Tortricid larva, which feeds upon the fruit of the currant in Oregon, and states that the codling moth is particularly numerous and destructive in that State. He reports further observations upon *Rhizobius ventralis*, the imported Australian enemy of the black scale, and states that six annual generations of this beetle may be expected in southern California.

The agent at Los Angeles, Mr. D. W. Coquillett, has somewhat exhaustively studied several species of economic importance in his vicinity, and reports upon these as well as upon the use of arseniuretted and sulphuretted hydrogen as insecticides. In addition to his usual laboratory and field work he has cared for the colonies of imported Australian insects sent and brought over by Mr. Koebele last year, and has made a tour of inspection of the other colonies placed by the State board of agriculture and by himself. His report in regard to this matter is published in Insect Life (Vol. VI, pp. 24–26). The insects studied are two species of span-worms found upon English walnut, one of which—*Boarmia plumogeraria* Hulst—was mentioned in Bulletin No. 30 of this division. The other species is *Prochoerodes nubilator* Pack. The latter species, while preferring English walnut, is also found upon apple and willow trees. The life-histories of both species are exhibited in considerable detail in the report. The ordinary canker-worm remedies are recommended for the first and Paris-green spray for the second. The orange leaf-roller (*Tortrix citrana* Fernald) has also been studied in full. It occurs upon willow, oak, wild walnut, and goldenrod in addition to citrus trees. It is considered not to be an indigenous species, but was probably imported from some of the Pacific islands. Incidental to his account of this species, Mr. Coquillett records the fact that the larva of *Heliothis armiger* was found boring into a green orange at Anaheim by Mr. F. G. Ryan. The brassy cutworm (*Tæniocampa rufula* Grote) is mentioned as having done considerable damage to apples, pears, and peaches, burrowing into the fruit, and it is further stated that the larva of *Heliothis armiger* also occasionally damages peaches in California. A somewhat extended report is made upon the tent caterpillars of California, including some consideration of *Clisiocampa thoracica* Stretch, *C. californica* Pack., and *C. constricta* Stretch. Mr. Coquillett's experiments with the arseniuretted and sulphuretted hydrogen gases as insecticides were under-

taken on account of the fact that he was somewhat dissatisfied with his former experiments with these gases. The most careful tests, however, only confirmed him in his former opinion that, in regard to expense and effectiveness, hydrocyanic gas is preferable to either of these. His methods and results are given in full in his report.

Iowa.—The Iowa agent, Prof. H. Osborn, reports the season to have been somewhat exceptional in that a number of usually inconspicuous species have become seriously abundant in that State. This has been especially true of the clover-hay worm (*Asopia costalis*), the wheat-head army worm (*Leucania albilinea*), the clover-seed caterpillar (*Grapholitha interstinctana*), and the horn-fly (*Hæmatobia serrata*). From the conditions present during the past season Prof. Osborn is of the opinion that destructive locusts will be particularly abundant in Iowa next summer, unless their natural enemies succeed in killing them off more extensively than at present seems probable. An interesting series of exact observations on the hatching of the eggs of the horse bot-fly has been made. The details are reported in full and the summarized results are as follows:

(1) The eggs of the horse bot do not hatch except by the assistance of the horse's tongue.

(2) Hatching does not ordinarily occur within ten or twelve days and possibly longer, or if during this period, only on very continuous and active licking of the horses.

(3) Hatching takes place most readily during the third to fifth week after oviposition.

(4) The majority of the larvæ lose their vitality after thirty-five to forty days.

(5) Larvæ may retain their vitality and show great activity upon hatching as late as thirty-nine days after oviposition.

(6) It is possible, though not normal, for eggs to hatch without moisture or friction.

(7) The scraping off of the eggs or their removal or destruction by means of washes will be very effective, even if not used oftener than once in two weeks during the period of oviposition, and probably a single thorough removal of the eggs after the period of oviposition has passed will prevent the greater majority of bots from access to the stomach.

The wheat-head army worm seems to have been destructive to timothy seed heads and not to wheat, and the recommendation to cut the crop for hay immediately upon the presence of worms in numbers being noticed has been followed with considerable saving from otherwise certain loss. Other insects briefly reported upon are the sod web-worm (*Crambus exsiccatus*), the little apple-leaf folder (*Teras minuta*), the apple-leaf skeletonizer (*Pempelia hammondi*), and a new grass and clover pyralid (*Nomophila noctuida*). The clover seed midge (*Cecidomyia leguminicola*) is said to be causing considerable damage in Iowa, although its injury is subordinate to that of the clover-seed caterpillar. The old plan, originally suggested by Comstock and later by Weed (C. M.) and Fletcher, of cutting early for the hay crop does not seem to meet with favor among the Iowa farmers, and many of them prefer to pasture the clover fields during the spring months, so as to prevent the development of the spring brood of midges. Prof. Osborn points out the very obvious fact that the clover should be allowed to head before the stock is turned in to pasture.

Nebraska.—Mr. Lawrence Bruner, the Nebraska agent, reports that the chinch bug and numerous injurious locusts have been very abundant during the present season, the latter insects consuming nearly one-third of the grass growth of the entire State. A new enemy to the sugar beet in the shape of a snout beetle (*Tanymecus confertus*) destroyed 12 acres of young beets during the season. The sugar-beet web-worm (*Loxostege sticticalis*) was less numerous than last year. The army

worm (*Leucania unipuncta*) was numerous and destructive in the northern and western parts of the State, and also in some parts of western Kansas. It was greatly infested by parasites, and was sought after by flocks of Bartram's sandpiper and the prairie chicken and sharp-tailed grouse. The cucumber plant louse (*Siphonophora citrulli*) appeared in the vicinity of Omaha, but was checked by timely application of kerosene emulsion and whale-oil soap. A large series of experiments with the chinch-bug disease, studied by Prof. F. H. Snow, was carried out. The results of the experiments were more favorable than anticipated. Laboratory experiments were perfectly successful, but in the immediate vicinity no field tests could be made. Two hundred lots of diseased bugs were sent out from the station, each accompanied by a letter of instructions. About one-half of those farmers who reported stated that the infection was a success. Some had no occasion to try it, others failed to follow instructions closely and failed, and some complete failures were also reported where the instructions were very closely followed. The details of the reports of those persons who found the treatment successful are looked forward to with interest, but from our present information we are unable to state whether the disease did not appear with apparent spontaneity in adjoining and untreated sections of the country.

Maine and Rhode Island.—Dr. A. S. Packard, who was temporarily employed during the summer to make further observations on the subject of forest insects, reports that there was a remarkable dearth of insect life, especially of caterpillars and other larvæ which feed exposed on the foliage of trees. This condition prevailed to a greater or less degree throughout New England. The region on the shores of the Casco Bay, which in 1878–'87 was ravaged by the spruce worm (*Tortrix fumiferana*), as described in the Fifth Report of the U. S. Entomological Commission, has greatly changed in appearance since 1887 by the rapid growth of young spruce and firs, which have sprung up since the removal of the old growth. This new growth does not seem to have been damaged by this insect. The larches or hackmatacks in Maine have in general recovered from the attacks of the larch worm (*Nematus erichsonii*), which was so prevalent several years ago, and which was treated by Dr. Packard in the report of the Entomologist of this Department for 1883. No specimens of the worm or of its adult form were collected. The effect of the extensive defoliation has been to destroy a few old trees, but the younger ones have in the main recuperated. A peculiar form of damage to fir has been studied. The small larva of *Blastobasis chalcofrontella* has been injuring the bases or sheaths of the leaves, causing hypertrophy, on which a mass of excrement is gathered. There seems to be but one annual generation. Another insect, which is not determined, cuts off the needles on the twigs of spruce, and has been studied in the larval state only. The life-history of *Aplodes coniferana*, which lives among the leaflets at the ends of the shoots, has been studied carefully, and a number of other insects have been noted or studied to some extent.

Missouri.—The agent at Kirkwood, Mo., Miss Mary E. Murtfeldt, sends in a very interesting series of notes on the insects which have been injurious in that State during the past season. She reports the appearance in great numbers of the army worm (*Leucania unipuncta*) in hay and grain fields contiguous to streams and low lands, and also together with other cutworms in vegetable gardens in St. Louis County. Indigenous locusts were very abundant the latter part of the season, and the species noted as most injurious were *Schistocerca ameri-*

cana, *Œdipoda sulphurea*, *Œ. xanthoptera*, *Melanoplus bivittatus*, and *M. femur-rubrum*. In some of the nurseries and newly set orchards in St. Louis County not a leaf was left on apple, pear, and plum trees, and the tender twigs were barked in many instances. In the early part of the season the Buffalo tree-hopper (*Ceresa bubalus*) was found to do great damage by its oviposition in the twigs of young fruit trees. An important and abundant egg parasite of this insect—a new species of Cosmocoma—was reared by this agent. Another leaf-hopper (*Ormenis pruinosa*) was very abundant in vineyards, blighting leaves and twigs. An undescribed Dryinus parasite was found attacking this insect. The Osage orange pyralid (*Loxostege macluræ*) was found to be spreading all over the State, its work being disastrous upon young hedges. Spraying with Paris green during the months of June and July was found to be a reliable remedy. The bagworm (*Thyridopteryx ephemeræformis*) was particularly abundant and probably the most noticable insect of the season. About 50 per cent of the bags, however, were parasitized by *Catolaccus thyridopterygis*, which breeds in the egg masses. The horn-fly (*Hæmatobia serrata*) was very abundant. Liquid tar was found to be the best repellant, its effects lasting for a week or ten days. The protracted drought of July and August greatly reduced the numbers of this insect, as the larvae were unable to develop in the dung, since it dried so quickly. Chickens in the stable yard and pasture rendered good service by scratching into and spreading the droppings and picking out whatever larvae were therein contained. *Scolytus rugulosus* appeared in several localities upon peach, plum, and cherry, and the pear-tree Ægeriid was reported to have done some damage to apple in Oregon County, a new habit on the part of this insect. Considerable attention was paid to the peach and plum bark-louse (*Lecanium persicæ*). The life history of this insect was well worked out and the male was found, an interesting and important discovery, as the male of this species has never before been observed. An imported pest of linden and other shade trees, in the shape of a leaf-roller (*Pantographa lineata*), was also carefully studied.

THE SAN JOSÉ OR PERNICIOUS SCALE.

(*Aspidiotus perniciosus* Comst.)

Order HEMIPTERA; Family COCCIDÆ.

[Plate I; Fig. 1.]

PREVIOUS INVESTIGATIONS.

In the Annual Report of this Department for 1880 Prof. J. H. Comstock described under the above name an insect which he had collected in Santa Clara County, Cal. He stated that from what he had seen of the species he considered it to be the most pernicious scale-insect known in this country. He had never seen any other species so abundant as this was in certain orchards, and was told that it infested all the deciduous fruits grown in California except the peach, the apricot, and the black Tartarian cherry. As a remedy he suggested the use of strong alkaline washes.

Until very recently the San José scale has been confined to the Pacific coast, but has extended north to Washington and south to the Mexican border, and has become, perhaps, the chief enemy to Pacific-

coast horticulture. Considerable attention has naturally been paid to the species by California horticulturists.

In 1883 Matthew Cooke published figures of the larva, male pupa, and adult male, together with the adult female scales on twig and fruit. He stated that the insect was first noticed by fruit shippers as infesting fruit in 1873 at San José, Santa Clara County. From that time it spread rapidly until 1880, and but little effort was made to exterminate it. In the winter of 1881–'82 crude petroleum was applied extensively; in some cases with good results, but in the majority of instances with great harm to the trees, many trees dying from the effects. The remedies recommended were 1 pound of concentrated lye to a gallon of water and 6 pounds of caustic soda to 12 ounces of potash and 8 gallons of water. These remedies were to be applied only at the dormant seasons. While the tree is in leaf, 1 pound of whale-oil soap, one-third of a pound of sulphur, and an ounce and a half of lye or caustic soda to a gallon of water was recommended.

In 1884 the late Dr. S. F. Chapin, in his biennial report as State inspector of fruit pests, mentioned the San José scale, but stated that in Santa Clara County, where it first appeared, there had been a most gratifying decrease in its numbers and in the destructive effects following its presence, both results having been brought about by the intelligent and well-directed efforts of the fruit-growers. He stated that the scale had been found at that time in many different localities in the State, but had not caused any great decrease in orchard products. He urged that the pest should be watched and treated in its incipiency.

In the biennial report of the State board of horticulture of California for 1885–'86, the late W. G. Klee, then State inspector of fruit pests, published a short account of the insect, illustrating its characteristic appearance upon twig, leaf, and fruit. Mr. Klee stated that the insect has three distinct broods—one in June, one in August, and one in October; but that these broods overlap, and in consequence the summer washes are not thorough remedies unless frequently repeated. He therefore recommended winter treatment, consisting of the cutting back and thorough thinning of all trees above 20 feet in height, together with thorough scrubbing of the rough bark of the old trees and the application of one-half pound of concentrated lye, one-half pound of commercial potash, and 5 quarts of water.

In the Proceedings of the Eighth Fruit-growers' Convention, published in the report of the State board of horticulture for 1887–'88, Prof. C. H. Dwinelle is said to have reported the most perfect success in fighting the San José scale in Sonoma County, Cal. A seriously infested orchard was treated with absolutely complete success by means of a wash composed of one-half pound of commercial potash, one-half pound of caustic soda, and 5 quarts of water. This was applied when the trees were in a dormant condition.

In the report of the same board for 1889 a reprint is given of Comstock's description in an article upon scale-insects and remedies. Several formulæ for summer and winter use are given, the most successful of which, and the one which has come into most general use, being the so-called lime-sulphur-salt wash for winter use. This wash consists of 40 pounds of unslaked lime, 20 pounds of sulphur, 15 pounds of stock salt, and water to make 60 gallons. The summer washes comprise potash and caustic soda, whale oil soap and sulphur, with a slight admixture of caustic soda and potash, and a mixture of tallow and resin with a small quantity of caustic soda and potash. In the report of the board for 1891 Mr. Alexander Craw published an article entitled

"Insect pests and their extermination," in which he briefly discusses this species. He considers it to be a very serious pest of deciduous trees, but states that the remedies just mentioned are so cheap and effective that no excuse can be tolerated for a seriously infested orchard. He further stated that a Chalcidid fly (*Aphelinus fuscipennis* Howard) had been found doing such effective work in subduing the species in an orchard in the neighborhood of Los Angeles that a complete restoration of the orchard was confidently expected.

In Bulletin 26 of this division Mr. Coquillett, in his report on the scale-insects of California, devotes four pages to this species. He states that its origin is uncertain, but that the fact of its being so frequently found upon plants imported from Japan would seem to point to that country as its original home. He states that the species never attacks citrus or coniferous trees, and that the LeConte pear, when growing in the midst of other varieties of pear, is almost exempt. The twice-stabbed ladybird (*Chilocorus bivulnerus*) is mentioned as being the most abundant and efficacious enemy of the scale, although Mr. Coquillett has never known an instance where even one single tree has been entirely or very nearly freed from the scale by the work of this beetle. The article concludes with a series of experiments with washes. The result of these experiments was that the resin and caustic soda wash recommended by Mr. Coquillet in Bulletin 23 of the division was found to be superior to the others. This wash is to be applied only during the dormant season, and consists of 30 pounds of resin, 9 pounds of 70 per cent caustic soda, 4½ pints of fish oil, and water to make 100 gallons.

Mr. Coquillett's testimony as to the good offices of *Chilocorus bivulnerus* coincides with that of other observers, but a surprising instance, which indicates that the species may occasionally prove extremely effective, was mentioned in The California Fruit Grower in 1892. It was there stated that Mr. N. W. Motheral procured a number of these beetles in San Diego County [date not given] and placed them in some orchards in Tulare County which were badly infested with the scale. They did not appear to multiply greatly until the spring of 1892, "when immense numbers appeared simultaneously and completely cleared the orchards of the county of the scale."

An interesting ladybird of the genus Scymnus was found in 1892 by Dr. Blaisdell preying upon the San José scale at the Coronado parks, near San Diego. This species was described by Dr. Blaisdell as *Scymnus lophanthæ* n. sp., but is one of the species imported by Mr. Koebele from Australia, and has not proved very effective in destroying the Aspidiotus.

In the September, 1892, number of the Agricultural Gazette of New South Wales, Mr. A. Sidney Olliff reported the receipt of a typical series of *Aspidiotus perniciosus* on the fruit, leaves, and twigs of pear from West Maitland, New South Wales. Mr. Olliff further stated that although this species had not previously been recorded as occurring in Australia, it had been known to some fruit-growers for a number of years.

In an important paper read by Mr. Alexander Craw before the State Horticultural Society of California, December, 1892, the San José scale is stated to be unquestionably of foreign origin, and it is further surmised, on the authority of Mr. John Britton, of San José, that it was introduced into California upon trees received from Chile by the late James Lick.

In Bulletin 7 of the New Mexico College of Agriculture, published in June, 1892, Mr. C. H. Tyler Townsend, entomologist of the station,

records the occurrence of the species at Las Cruces upon apple, pear, plum, peach, quince, and rose, and states that it was brought into New Mexico on young trees from California. The winter eggs are mentioned in Mr. Townsend's account as turning orange-yellow in spring and hatching the first or second week in May.

SUDDEN APPEARANCE OF THE SPECIES IN THE EAST.

The first week in August of the present year, Dr. C. H. Hedges, of Charlottesville, Va., sent specimens of pears and peaches affected by this insect to the Division of Vegetable Pathology of this Department, on the supposition that the scales were the manifestation of a fungous disease. They were referred to this division and Dr. Hedges was informed of the destructive character of the insect, and advised to spray with kerosene emulsion, as examination of the specimens showed that the insects were hatching at the time. He was unable to trace the origin of the trouble. He sent specimens from pear, currant, plum, Japanese plum, and dwarf apple.

In view of the great importance of the subject, Mr. E. A. Schwarz was sent to Charlottesville about the middle of August to make a thorough investigation, and in December Mr. D. W. Coquillett was sent to continue them, and to definitely delineate the area of infection. From the detailed reports submitted it appears that the scale occurs most abundantly in a little pear orchard forming a square of nearly an acre about one-third of a mile from the center of the city, adjoining one of the main roads leading into the open country. The orchard is practically isolated, being bounded upon one side by a vineyard, on another by the garden of a neighbor, on a third side by the road, and on the fourth by a lawn. It is planted with choice dwarf fruit trees, mainly pears. They are crowded together, and in many cases the branches interlock. The orchard was set out about eight years ago, and is now very badly infested. The quince and Japan persimmon carry no scales; a few occur upon dwarf apples and a few upon peaches. The Lawrence pears are also but slightly affected. The Duchesse d'Angoulême and its varieties, and the Bartlett and its varieties are very badly attacked, particularly the former. Raspberry bushes are not affected, but currant bushes are covered. A few specimens also occurred upon rose bushes. Two hundred feet away from the infested orchard, and in the middle of the vineyard, other apple, peach, and pear trees occur, but all are absolutely free from scales. Two old apple orchards at a very considerable distance were also absolutely free. In point of fact, the insect has not spread to the north, east, or west. Towards the south, however, it has spread to some extent into the garden of a neighbor. This is a flower garden, but contains a few scattered fruit trees. In this garden the scales were found in moderate numbers on a peach tree, on some pear trees, and on two rose-bushes. Still further south is another garden belonging to a neighbor, and in this garden a few specimens of the scale were found upon a single pear tree.

The insect is therefore definitely limited and confined to a small space, and there seems to be no doubt that the species made its first appearance in Dr. Hedges' pear orchard. It is also undoubtedly a recent importation, since the orchard was planted only eight years ago, and since the species has spread so slightly.

Mr. Schwarz was able to gain no definite information concerning the mode of importation. Dr. Hedges has never bought any nursery stock

or other plants from California. His oldest trees were purchased eight years ago in New York. Certain others were purchased in Augusta, Ga., three years ago, and two years ago another lot was obtained from Crozet, Albemarle County, Va. The time of purchase of the last lot coincides with the time when the scale was first noticed, but Dr. Hedges is positive that these trees were not infested when purchased, and states that the scales were first noticed at another point in the orchard among the oldest pear trees, near certain old currant bushes which died and were removed before the scales were noticed upon the trees. Mr. Schwarz then inquired as to the history of these currant bushes and ascertained that they were purchased eight years ago from a New Jersey nursery. Dr. Hedges thinks that they died from a scale-insect attack, but since this was long before the scales were noticed in the pear trees, the statement is doubtful. Moreover, had the insect been originally introduced upon currant bushes eight years ago, the whole orchard would probably have been infested long since, and the insect would have spread to a much greater distance.

The question as to the mode of importation is, then, surrounded with considerable difficulty, and it would seem, at the first glance, more plausible that the insect had become accidentally established from California fruit than from nursery stock. This was the conclusion to which Mr. Schwarz came after his investigation. He found that California pears are sold in the fruit stores of Charlottesville and also upon the trains of the Richmond and Danville Railroad passing through the city. He therefore suggests the plausible idea that some person passing along the highway had tossed the rejected portions of a pear over the fence, and that from this small beginning the difficulty originated. In support of this view it may be stated that the insects gather by preference in the pit around the calyx end of the fruit, where they are not likely to be noticed and from which point they can not be rubbed in polishing the fruit with a cloth. Against it, however, is the further fact that not a single specimen of this insect on California pears has ever been noticed in the Washington markets. Its appearance is so characteristic that it could hardly fail to attract the attention of an entomologist, and yet none of our assistants have ever seen one, although California pears are extremely abundant on the fruit stands of Washington, as in most of our Eastern cities. Moreover, the greatest care is exercised in California to offer only perfectly clean fruit for sale, and there are State laws prohibiting the sale of infested fruit. Two years and a half ago a case was reported in The California Fruit Grower, where a Riverside fruit dealer was fined $10 for selling fruit infested with this scale insect, and since that time the law has been more or less rigidly enforced. Moreover, if infested fruit were commonly brought to Eastern markets, cases similar to this would have been of frequent occurrence. Indeed, it is difficult to suppose that in this event the species would not have long since obtained a foothold all through the East, since it would easily establish itself upon almost any deciduous plant near which living specimens might find themselves. We are inclined, therefore, to think that while the origin through infested fruit is the most plausible explanation in this particular case, yet the danger of other similar occurrences in other Eastern orchards is not great.*

The most striking feature in the habits of the scale is its tendency to

* Since the above was written it has been found in other localities in the Atlantic States, and in many instances traced to an extensive nursery in New Jersey.

infest only the extremities of the trees, or the new growth, especially of the lower branches and the fruit. The leaves are attacked (and Mr. Schwarz found this particularly true of the Duchess and Bartlett pear trees) along the midrib on the upper side of the leaf in one, two, or more quite regular rows, and also to some extent along the side ribs, the male scales predominating over the female in such situations. The infested leaves turn purplish brown, but do not have a tendency to fall. No eggs or the remains of eggs could be found by Mr. Schwarz under the female scales at the time of his visit, and usually only one or two larvæ. The species would therefore seem to be viviparous, at least during part of its life cycle, though eggs are mentioned by both Comstock and Townsend in their records and observations. While three generations have been observed in California, there would seem to be, from Mr. Schwarz's notes, no definite succession of generations, but a gradual hatching, or rather a gradual birth, for several months.

NATURAL ENEMIES AT CHARLOTTESVILLE.

No parasites, and no scales from which parasites had issued, were observed at Charlottesville. The common little Malachiid beetle (*Collops quadrimaculatus*) was observed feeding in small numbers upon the newly-hatched larvæ. The Coccinellid beetle (*Pentilia misella*) and its larvæ were very abundant on the infested trees, and this species Mr. Schwarz thinks a very important enemy of the scale. The beetles seem to prefer the full-grown female scales, while the larvæ feed upon Aspidiotus larvæ. The larvæ customarily transform to pupa within the calyx of the pears. This little cavity was always found literally filled with a mass of young and old scales, full-grown Pentilia larvæ and pupæ, and recent imagos. The fact that this beetle, which is essentially an Eastern species, so readily and effectively began to feed upon this introduced scale is a very interesting one entomologically, and would justify an effort to introduce and colonize it in southern California.

HOW THE SPECIES IS DISTRIBUTED LOCALLY.

Some interesting observations were made by Mr. Schwarz upon the transporting of the young Coccid larvæ by other insects. This very Pentilia was unconsciously an active agent in this dangerous work. Hardly one of the beetles could be found which did not carry on its back at least one Aspidiotus larva, and sometimes three or four were found upon a single wing-cover of a beetle. A small black ant (*Monomorium minutum*) was abundant upon the pears, attracted by the juice emerging from the cracks, and almost every one of these ants carried on its back one or more specimens of the Coccid larvæ. Specimens of a little Chrysomelid beetle (*Typophorus canellus*) were also found upon the trees. Red and black specimens of these beetles occurred, and the interesting observation was made that while the Aspidiotus larvæ crawled freely upon the black individuals, no specimens were to be found upon the red ones. This same peculiar fact was also found to hold with the ants, since the red ant (*Formica schaufussi*) was abundant upon the pears, but no specimens were found bearing Aspidiotus larvæ, while, as just stated, the little black Monomorium was always found carrying specimens. Curiously enough, no ladybirds other than Pentilia were seen. The common twice-stabbed ladybird (*Chilocorus bivulnerus*), which is so active an enemy of scale-insects and plant-lice throughout the Southern States, was absent.

STAMPING OUT THE SPECIES AT CHARLOTTESVILLE.

Believing, from Mr. Schwarz's report, that the area in which the insect occurs around Charlottesville is yet limited, and feeling the importance of effectual steps being taken to stamp it out, because of the danger of its future spread to the rest of the State of Virginia and to the whole Atlantic fruit region, the Entomologist was anxious to still more definitely delimit its range, and Mr. D. W. Coquillett, who has had much experience with the insect in California, was directed to make a second survey of the field. He spent some time at Charlottesville in December, and his report fully confirms the observations of Mr. Schwarz, and shows that the species is yet limited to the region already indicated. Dr. C. H. Hedges and Mr. H. L. Lyman, who have both felt great interest in this matter, in correspondence with the division have shown a willingness to do all that can be done in exterminating it, and the State board of agriculture has appealed to the Department for its assistance in this matter. It is the purpose of the Entomologist before the close of the winter in coöperation with the State board of agriculture to adopt such measures as will effectually stamp it out. The burning of the fruit and leaves, and the thorough cutting back of the branches and their destruction by fire, would undoubtedly destroy a large proportion of the insects. But it is believed that in a case like this no risks should be run, and that the great bulk of the affected trees should be cut down to the ground and burned. Where it is desirable for any reason to save individual trees, it will be best to use the gas treatment; and in order that this work may be effectually done, the Entomologist has promised to have it superintended by the division, and to do everything possible on behalf of the Department to eradicate the insect from this location. It is a matter in which not only the community around Charlottesville is vitally interested, but also all the fruit-growers of the Eastern States.

CHARACTER OF THE SPECIES AND ITS GENERAL APPEARANCE.

At Plate I the species is shown as it appears on the fruit (Fig. 1), and an enlarged female scale (1*a*), in order that Eastern fruit-growers may readily recognize it. It is particularly urged upon those who read this report, and who have fruit orchards in the vicinity of Charlottesville, to examine their trees carefully and report to the Department. Every care should be exercised to prevent another accidental importation, and nursery stock or other plants from California and New Mexico should be thoroughly examined and disinfected or destroyed.

When occurring on twigs the species is not particularly characteristic in appearance. It resembles, in a mass, patches of dark gray scurfy material, though there is more or less purplish stain connected with it, particularly noticeable with individual scales. Seen under the lens it possesses the appearance shown at Fig. 1*a* on the plate. Upon the fruit, however, nothing can be more striking and characteristic, since each scale is surrounded by a purple ring, usually at least one-eighth of an inch in diameter. The male scale differs from the female by its smaller size, rather more elongate form, and, as we have already stated, is found more abundantly upon the leaves, while the females occur upon the twigs and fruit. Those stages of the insect which have not yet received scientific description will be described elsewhere, and upon Plate I is shown for the first time a characteristic figure of the young larva, while the ladybird found so abundantly by Mr. Schwarz is shown at Fig. 2.

THE WEST INDIAN PEACH DIASPIS.

(*Diaspis lanatus* Morg. and Ckll.)

Order HEMIPTERA; Family COCCIDÆ.

[Plate I, Fig. 3.]

HISTORY OF THE SPECIES IN THE ATLANTIC STATES.

In 1892 certain seedling peaches growing in rows in the grounds of the U. S. Department of Agriculture were found to be infested by a scale-insect which was immediately seen to be new to the United States. The most of the young trees were from an inch to an inch and a half in diameter at the base, and the lower halves of the trunks of a few of them were covered with the snowy white male scales, giving them the appearance of having been whitewashed, while the female scales were abundant upon the upper halves of the trunks and upon the main branches. The young twigs of those trees which were most badly infested were already dead and dry. The females resemble closely those of a new species of Aspidiotus upon peach which occurs in Texas and South Georgia, and which has not yet been characterized. The males, however, separate it from this species and place it in another genus. It also resembles somewhat the *Diaspis amygdali*, also occurring upon peach, which is mentioned in another section of this report. It is, however, smaller than this last species, and differs in the color of the female scale and in the method of its work. The only other Diaspis upon peach is the speciesd escribed by Signoret as *D. leperii* (Ann. Soc. Ent. de France, 1869, p. 437), but from the somewhat incomplete description of this species it differs in the groups of pores on the last segment of the full-grown female and in the arrangement of the spines and plates. From *D. ostreæformis*, which occurs upon pear, it differs in the color of both the male and the female scales and in the structural characters of the female, while from the common *D. rosæ* it differs in the shape of the female and her scale as well as in the groups of pores. *D. rosæ*, however, is no longer placed in this genus, but in *Aulacaspis* Cockerell, whereas the species under consideration is a nearly typical Diaspis.

The life history of the species has been carefully studied during the summer, and it has, in the meantime, increased greatly in numbers and has spread to several new peach trees.

Every effort was made, upon learning that it was a new pest, to ascertain the source from which the Washington specimens originally came, but these efforts up to the present time have been unsuccessful. The rows of young trees upon which it was found were started by assistants in the Division of Vegetable Pathology for the purpose of inoculation with peach yellows and other diseases of the peach, which that division was engaged in studying. The trees were raised from seed, and in consequence most careful search was made for specimens of the insect upon neighboring trees of other varieties. The entire part of the grounds in the vicinity of the trees was searched without result, and the superintendent of the grounds states that no changes have been made in the surrounding vegetation since the peach plantation was started. The only plants in the immediate vicinity are a large evergreen hedge, an Osage-orange hedge, some young fig trees, and a few grape vines, in addition to the ordinary couch grass and clover and a few chenopodiaceous weeds. It is possible that the young larvæ

may have been brought from a distance upon the feet of birds or upon winged insects, but it is hardly possible that the species, if occurring in any numbers, should not have been discovered even a block or more away. Later, it was found that although the peaches were all seedlings, a few very small twigs and buds had been brought from Delaware for inoculation purposes by Dr. Erwin F. Smith, and a few more from Still Pond, Md.

This introduces the possibility that the insect may have been brought upon these small pieces of peach, but Dr. Smith, who is a very keen observer and has paid a great deal of attention to insects, declares that the specimens brought were not affected by this insect. Moreover, he says that he has a most intimate acquaintance with the orchards from which the twigs and buds were brought, and that the occurrence of the new Diaspis in either of these orchards would certainly have attracted his attention. The origin of the infection on the Department grounds is, therefore, still obscure.

In September, 1893, peach twigs were received from Mr. S. S. Harvey, of Molino, Fla., which, upon examination, were found to be infested by female scales belonging to this species. It was learned from correspondence that they first made their appearance upon some young trees—peach and plum—which he had received from California about February, 1888. They were set out and made good growth that year, but upon looking them over in the fall he discovered some dead wood and even dead branches covered with scales. He cut off the dead wood and washed the trees carefully, as he found the scale upon all parts. During the summers of 1889 and 1890, whenever he found a tree infested, he took it up and burned it. During the winter of 1890–'91 he gave orders to cut out all the California peach and plum trees. They were set out in a pear orchard, with no other peaches or plums in the neighborhood. Something over 100 were thus destroyed. In 1892 he found several large two and three-year-old peach trees covered with the scale. They were half a mile from the spot where the California trees had stood. In the early part of 1893 he found the insect scattered over the orchard; not on all the trees, but here and there throughout an orchard of 2,000 to 3,000 trees. In September it had made very considerable progress. Up to June he had no doubt that he had brought the scale from California, but during that month he visited several orchards 80 miles to the east and found the scale at that point. He was informed that none of the growers in that vicinity had received any young trees from California. He thinks that the insect prefers the plum, especially the rapid-growing Japanese plums. They were very abundant upon sprouts putting out from the crowns of 300 old peach trees which he topped two years before. These sprouts were covered with the scale, while the new tops and the old stumps were free, even when the sprouts had run up into the new top of the stump. All these sprouts were grubbed out.

On October 26 last specimens of the same insect were received from Mrs. E. Johnson, of Bainbridge, Ga., with the statement that she found it attacking plum and peach trees in her orchard. Upon further inquiry it was ascertained that about four years since she purchased a small lot of peach and plum trees from a nurseryman in Thomasville, Ga. The following summer she noticed that one of the trees (a Chinese blood peach) was badly infested with the scale-insect. Some ineffective attempts at remedial work were made, but the insect gradually covered the tree, and in the summer of 1891 she cut it down and burned it. In the meantime she had enlarged her orchard with trees from nurseries

at Augusta and Waycross, and at about the time when she cut down the first peach tree she discovered that a plum tree near by was also affected. Since that time she has endeavored to destroy the scale, but at the time of writing it was present on from 25 to 30 trees. A later letter from Mrs. Johnson states that upon inquiry she had found that one of her acquaintances has had some trouble with this insect, and that this individual purchased the plum tree upon which it was first discovered from the same Thomasville (Ga.) nurseryman from whom Mrs. Johnson thinks that she received her original stock.

In December in a small lot of Jamaica scale-insects sent by Mr. T. D. A. Cockerell, specimens of this species, which bore the name of *Diaspis lanatus*, were recognized. Though familiar with the description of this species, which was drawn up by Mr. Morgan and published by Mr. Cockerell in the Journal of the Institute of Jamaica (Vol. I, p. 137, August, 1892), there was no indication of its occurrence upon rosaceous plants, but the most careful comparison with Mr. Cockerell's typical specimens fails to show any difference in structure, so that that *D. lanatus* described originally from specimens collected by Mr. Cockerell at Kingston on Capsicum and upon a malvaceous plant at Mandeville, is identical with the new peach scale of Florida, Georgia, and the District of Columbia.

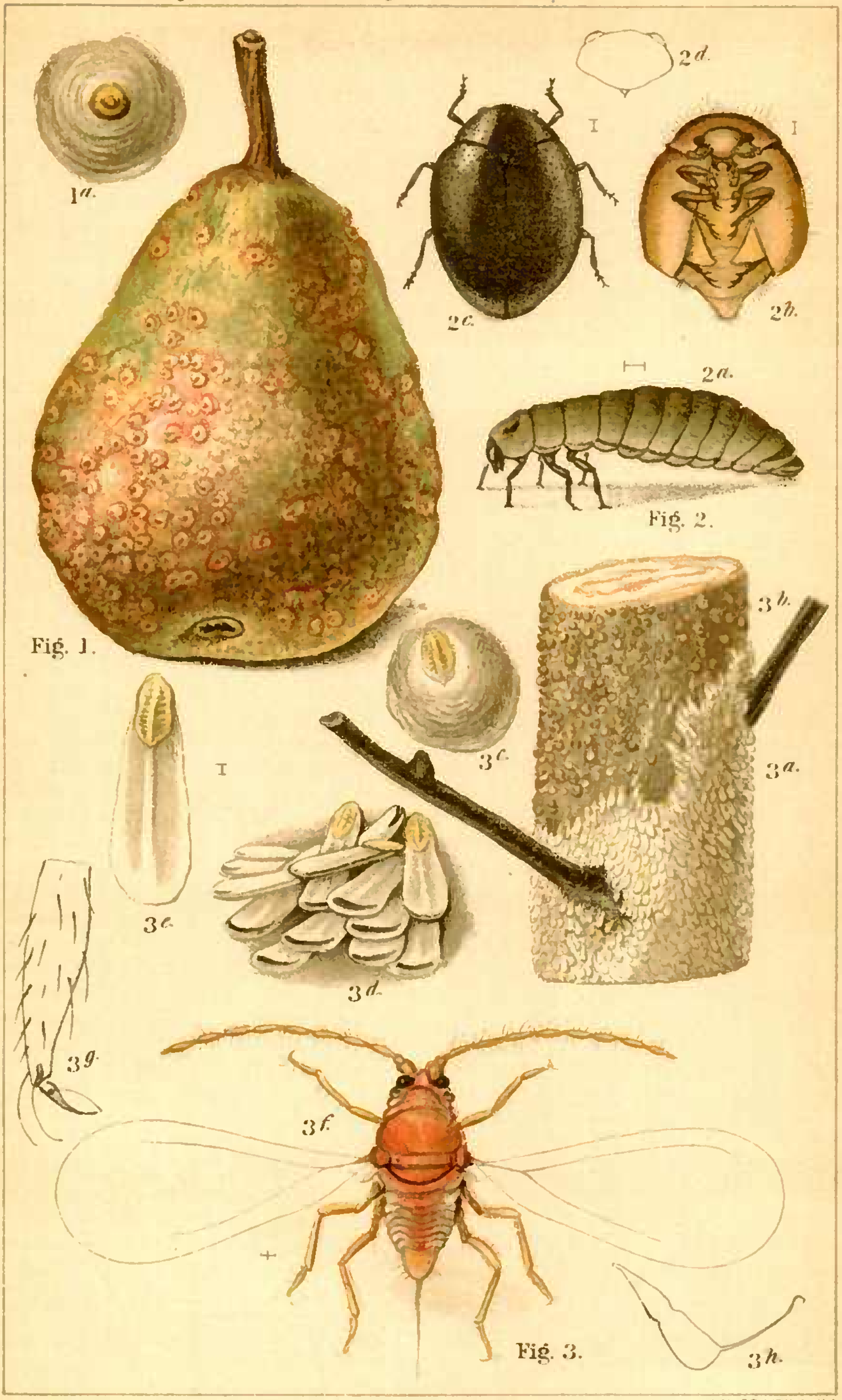
OCCURRENCE IN THE WEST INDIES.

The West Indian occurrence and range of the species are very interesting. The Entomologist has recently received from Prof. C. H. T. Townsend, Mr. Cockerell's successor in the curatorship of the Institute of Jamaica, specimens which were found upon grape and bastard cedar (*Guazuma ulmifolia*). Mr. Cockerell has also kindly sent from New Mexico his Jamaican notes upon the species, from which it appears that the food plants are very numerous and that the species varies considerably within what Mr. Cockerell considers to be well-defined specific limits. He has, therefore, proposed in manuscript several variety or race names which he has not thought worth while to publish. One form occurs on *Cycas media* in the Castleton Gardens, Jamaica; the typical form occurs upon stems of Oleander (the pink variety) in St. Andrews, Jamaica, and upon Capsicum and stems of *Argyreia speciosa* at Kingston. Another form occurs upon the bark and twigs of a malvaceous plant at Moneague, Jamaica, while another form occurs upon *Bryophyllum calycinum* at Mandeville, Jamaica, distorting and much injuring the plant. The typical form occurs also on Grand Cayman Island and at Port of Spain, Trinidad. In the latter locality it occurs upon *Carica papaya*, and was discovered by Mr. F. W. Urich.

In addition to these food plants Mr. Cockerell, in his paper entitled "Food plants of some Jamaican Coccidæ" in Insect Life (Vol. v, pp. 158-160, 245-247), mentions its occurrence upon the stems of French cotton (*Calotropis procera*) at the Parade Garden, Kingston, and upon okra (*Hibiscus esculentus*) in Castleton Gardens, Jamaica. The occurrence of the species upon peach is also mentioned in Mr. Cockerell's manuscript notes, as well as upon Pelargonium, Jasminum, and on the stems of cotton.

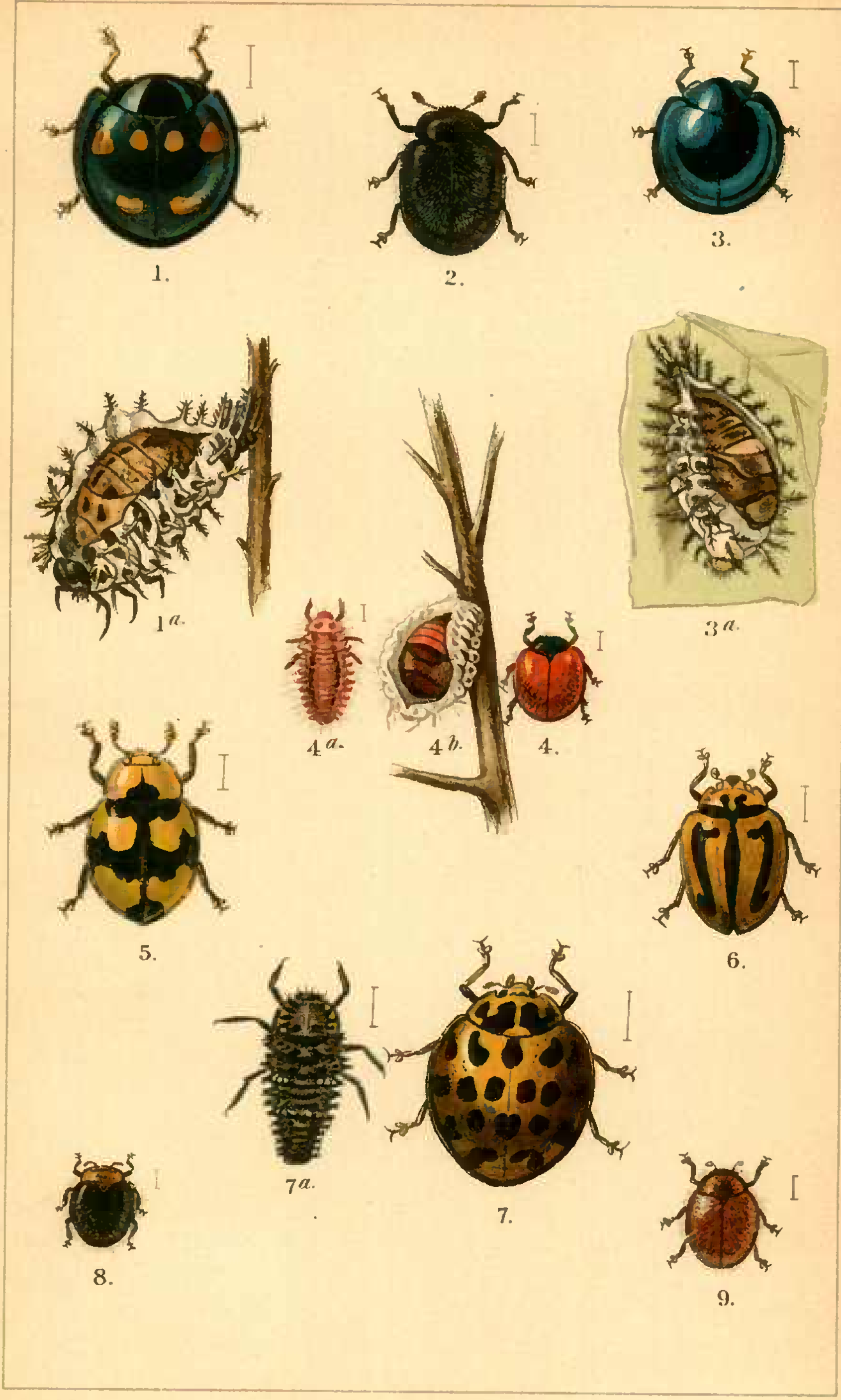
A DANGEROUS SPECIES.

From the above facts it is evident that the species is a very general feeder, and as a consequence much more dangerous than if it had but one or two food plants, as it will be all the more difficult to stamp it



AVIL CO. LITH. PHILA.

THE SAN JOSE SCALE AND THE NEW PEACH SCALE.



AVIL CO. LITH. PHILA.

INTRODUCED AUSTRALIAN LADYBIRDS.

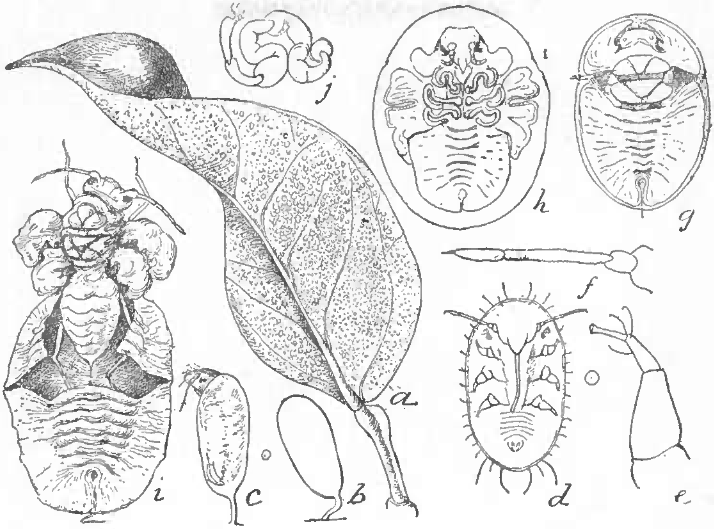


Fig. 1.

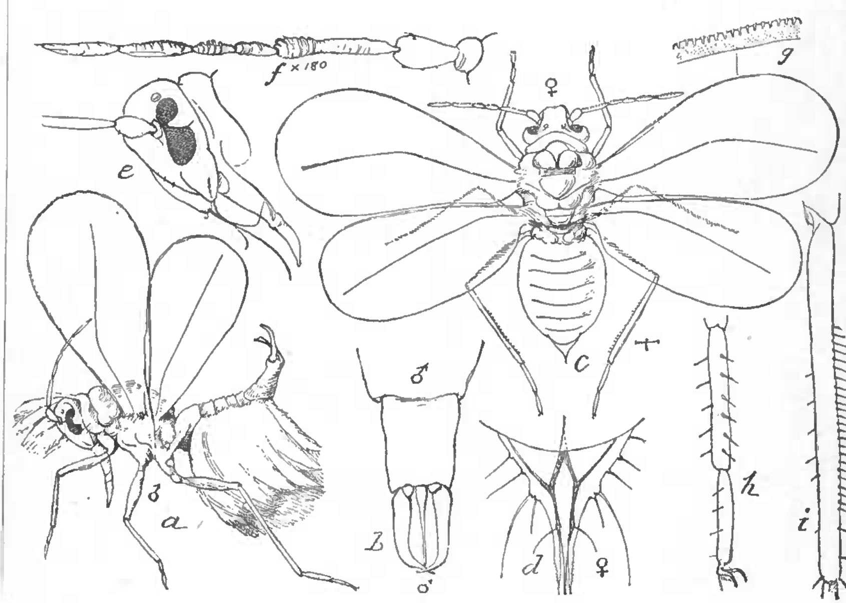


Fig. 2.

THE ORANGE MEALY-WING.

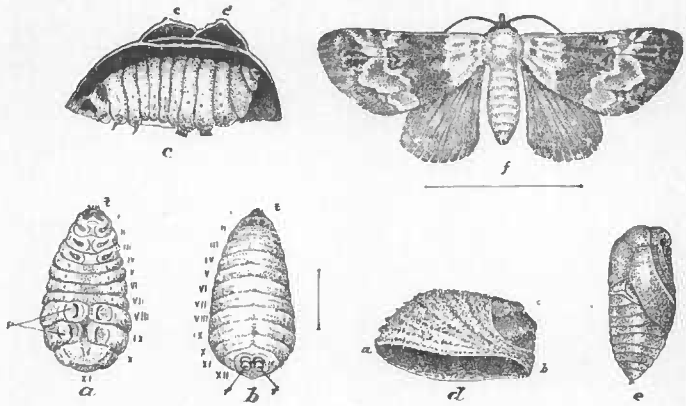


Fig. 1.

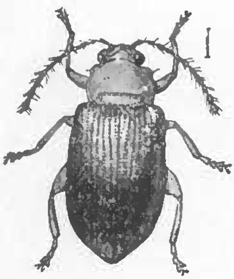


Fig. 2.

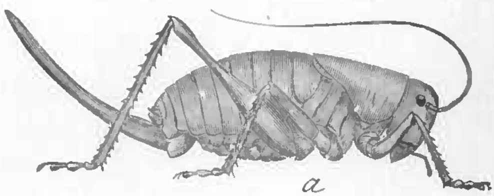


Fig. 3.

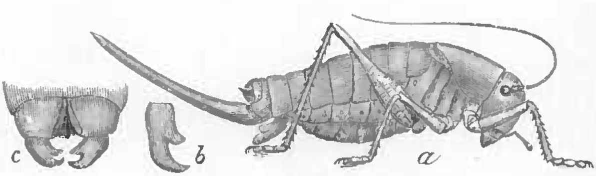


Fig. 4.

MISCELLANEOUS INSECTS.

out or prevent its reintroduction. So far, it is true, it is reported upon but one or two food plants in this country, but we shall, no doubt, before long hear of it upon many others unless, indeed, it can be eradicated from the localities in which it has obtained a foothold. There can be little question that it is a West Indian species, and that it has been brought into this country by some of the Southern importers of West Indian and other tropical and subtropical plants; and the Thomasville (Ga.) nurseryman above mentioned is open to at least a strong suspicion of the responsibility, either direct or indirect. The fact that it thrives as far north as the District of Columbia adds to the seriousness of the case and to the great desirability of eradicating the species upon its first appearance in any one locality. It is in the hope of helping to bring about such a consummation that this extended notice, with illustrations of the species, is given in this report. Proper measures have been taken to stamp it out at Washington, and the correspondents in Florida and Georgia have been urged to do likewise. Nevertheless, it seems to have already obtained such a foothold as to make it highly improbable that we shall be able to eradicate it. It multiplies with surprising rapidity, since, as we shall presently see, there are from three to four generations annually at Washington.

LIFE HISTORY.

When the insect was first discovered, in December, 1892, the lower halves of the trunks of the young peach trees were more or less completely covered with male scales, while the female scales mainly occupied the upper halves of the trunks. In March the female scales were examined and the eggs were plainly seen within their bodies by transmitted light. By the end of April they were found to be full of eggs, which appeared to be perfectly developed, although none had been deposited on April 24. Upon May 5 oviposition had begun, and upon May 13 the young larvæ were hatching by thousands. At this time experiments were made to ascertain whether these larvæ would settle upon the rose. A potted rose, free of scale, was tied to a badly infested peach tree, but none of the young scales migrated to it, although it was examined for ten days or more. The larvæ developed irregularly, and by May 23 some were already twice as large as others, and all seemed to be covered more or less densely with glistening white threads, while a few had begun to form a delicate scale. By May 26 a few had cast their first skin. By June 15 the females had cast their second skin, while the male scale was fully formed and most of the male larvæ had transformed to the pupa state, a few having already become winged. The next day many males issued. About the end of June oviposition began again, and females attained full size the middle of August, egg-laying for the third time beginning at the end of August. Another brood developed the end of October.

NOTE.—Plate II, which illustrates Australian lady-birds recently introduced into California, has no text reference, owing to the fact that a certain portion of the manuscript of the report was cut out on account of the necessity for brevity. The plate had, however, already been put into the hands of the lithographer, and is therefore published without further comment.

EXPLANATION OF PLATES TO REPORT OF ENTOMOLOGIST.

[Where figures are enlarged the natural sizes are indicated in hair lines at side, unless already indicated in some other way on plate.]

Explanation to Plate I.

THE SAN JOSÉ SCALE AND THE NEW PEACH SCALE.

Fig. 1. *Aspidiotus perniciosus;* adult females *in situ* upon pear; *a*, adult female scale—enlarged (original).

Fig. 2. *Pentilia misella:* An enemy of the San José scale in Virginia; *a*, larva; *b*, pupa; *c*, adult—enlarged; *d*, scutellum of adult—still more enlarged (original).

Fig. 3. *Diaspis lanatus: a*, male scales *in situ* on trunk of young peach tree; *b*, full-grown female scales, same—natural size; *c*, female scale; *d*, male scales—enlarged; *e*, male scale—still more enlarged; *f*, adult male scale—still more enlarged; *g*, tarsus of adult male; *h*, poiser and hook of same—very greatly enlarged (original).

Explanation to Plate II.

[All of these are drawn to the same scale, and the figures therefore represent relative sizes.]

THE INTRODUCED AUSTRALIAN LADYBIRDS.

Fig. 1. *Orcus australasiæ:* adult; 1*a*, pupa of same in last larval skin—enlarged (original).

Fig. 2. *Rhizobius ventralis:* adult—enlarged (original).

Fig. 3. *Orcus chalybeus:* adult; 3*a*, pupa of same in last larval skin—enlarged (original).

Fig. 4. *Novius koebelei:* adult; 4*a*, larva of same; 4*b*, pupa in last larval skin—enlarged (original).

Fig. 5. *Psyllobora galbula:* adult—enlarged (original).

Fig. 6. *Alesia frenata:* adult—enlarged (original).

Fig. 7. *Leis conformis:* adult; 7*a*, larva of same—enlarged (original).

Fig. 8. *Rhizobius toowoombæ:* adult—enlarged (original).

Fig. 9. *Rhizobius debilis:* adult—enlarged (original).

Explanation to Plate III.

THE ORANGE MEALY-WING.

Fig. 1. *Aleyrodes citri: a*, orange leaf badly infested by full-grown larvæ—natural size; *b*, outline of egg; *c*, young larva in the act of hatching from egg; *d*, newly hatched larva seen from below—enlarged; *e*, leg of *d*; *f*, antenna of *d*—still more enlarged; *g*, advanced pupa; *h*, adult nearly ready to emerge and seen through pupa skin; *i*, adult with wings still unfolded, in the act of emerging from pupa shell—enlarged; *j*, leg of *h*—still more enlarged (from Insect Life).

Fig. 2. *Aleyrodes citri: a*, adult male seen from side and showing waxy tufts; *b*, anal segments and claspers of same seen from above; *c*, adult female seen from above, with wings spread; *d*, anal segment and ovipositor of the same; *e*, head of same from side; *f*, antenna of same; *g*, costal border of fore wing; *h*, hind tarsus; *i*, hind tibia; *a* and *c* enlarged; *b*, *d*, *e*, *f*, *g*, *h*, *i*, still more enlarged (from Insect Life).

Explanation to Plate IV.

MISCELLANEOUS INSECTS.

Fig. 1. *Erastria scitula: a*, larva from below; *b*, same from above; *c*, above, in case; *d*, case of full-grown larva; *e*, pupa; *f*, moth—enlarged (after Rouzaud, from Insect Life).

Fig. 2. *Crepidodera rufipes:* adult—enlarged (from Insect Life).

Fig. 3. *Anabrus simplex:* adult female—natural size (after Riley).

Fig. 4. *Anabrus purpurascens: a*, adult female; *c*, end of male abdomen, showing claspers *b*—natural size (after Riley).

REPORT OF THE ORNITHOLOGIST AND MAMMALOGIST.

SIR: I have the honor to submit herewith my eighth annual report on the work of the Division of Ornithology and Mammalogy, covering the year 1893.

Very respectfully,

C. HART MERRIAM,
Chief.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE YEAR.

The efforts of the division have been directed largely toward the completion of investigations begun in previous years, investigations relating both to the determination of the natural faunal or life zones of the country, and to the food habits and distribution of mammals and birds of economic importance to agriculture.

Three publications have been issued during the year: (1) An economic bulletin on the hawks and owls of the United States; (2) an economic bulletin on the prairie ground squirrels or spermophiles of the Mississippi Valley; (3) a technical publication containing part of the results of the Death Valley Expedition.

The work on hawks and owls was illustrated by 26 fine colored plates, paid for out of the lump fund of the division, and was in such demand that the edition of 5,000 copies was exhausted almost as soon as published, since which time many thousands of additional applications for it have been received.

The bulletin on prairie ground squirrels was illustrated by 3 full-page colored plates and by colored maps showing the area inhabited by each species. The edition (also 5,000 copies) proved insufficient for the demand and is now practically exhausted.

A bulletin on the crow, comprising the results of several years' study of the relations of this interesting bird to agriculture, is now ready for the press; and a bulletin on the pocket gophers, similar in scope and character to the one already issued on the prairie ground squirrels, will probably be ready for distribution before the present report is issued. Other bulletins are in an advanced stage of preparation.

In the year 1893 more than 6,500 letters were received, many of them accompanied by schedules, reports, and miscellaneous notes, all of which were examined and filed for future reference. During the same time about 3,800 letters were written, several hundred schedules distributed to observers and correspondents, and upwards of 700 packages

sent out. Other routine work has consisted in the identification of specimens (about 400 separate lots or packages of which have been received), forwarding supplies to field agents, the care of collections, correcting proof, compiling reference lists of publications useful in the work of the division, and miscellaneous work.

SCOPE OF THE WORK.

The investigations carried on by the division are naturally divided into two groups—one relating to the geographic distribution of species in the widest sense, the other confined to the study of birds and mammals of immediate interest to the farmer because of their relation to agriculture. During the year work has been pushed along these lines as vigorously as the means at command would allow.

GEOGRAPHIC DISTRIBUTION.

The interest of the agriculturist in the study of geographic distribution lies in the fact first pointed out by this division, that the territory of the United States may be divided into a definite number of belts or zones, each of which is characterized by the presence of certain native animals and plants and which, under cultivation, is fitted for particular agricultural products. The reason why certain animals and plants are restricted to particular areas or belts, where no visible barriers exist to prevent dispersion, is that the sensitive organizations of such species have become adapted to the particular physical and climatic conditions there prevalent and are not sufficiently plastic to enable them to live under other conditions. What is true of animals and plants in a state of nature is true also of animals and plants as modified by man; for every race or breed of sheep, cattle, or swine, and every variety of grain, vegetable, or fruit thrives best under particular conditions of temperature, moisture, and exposure.

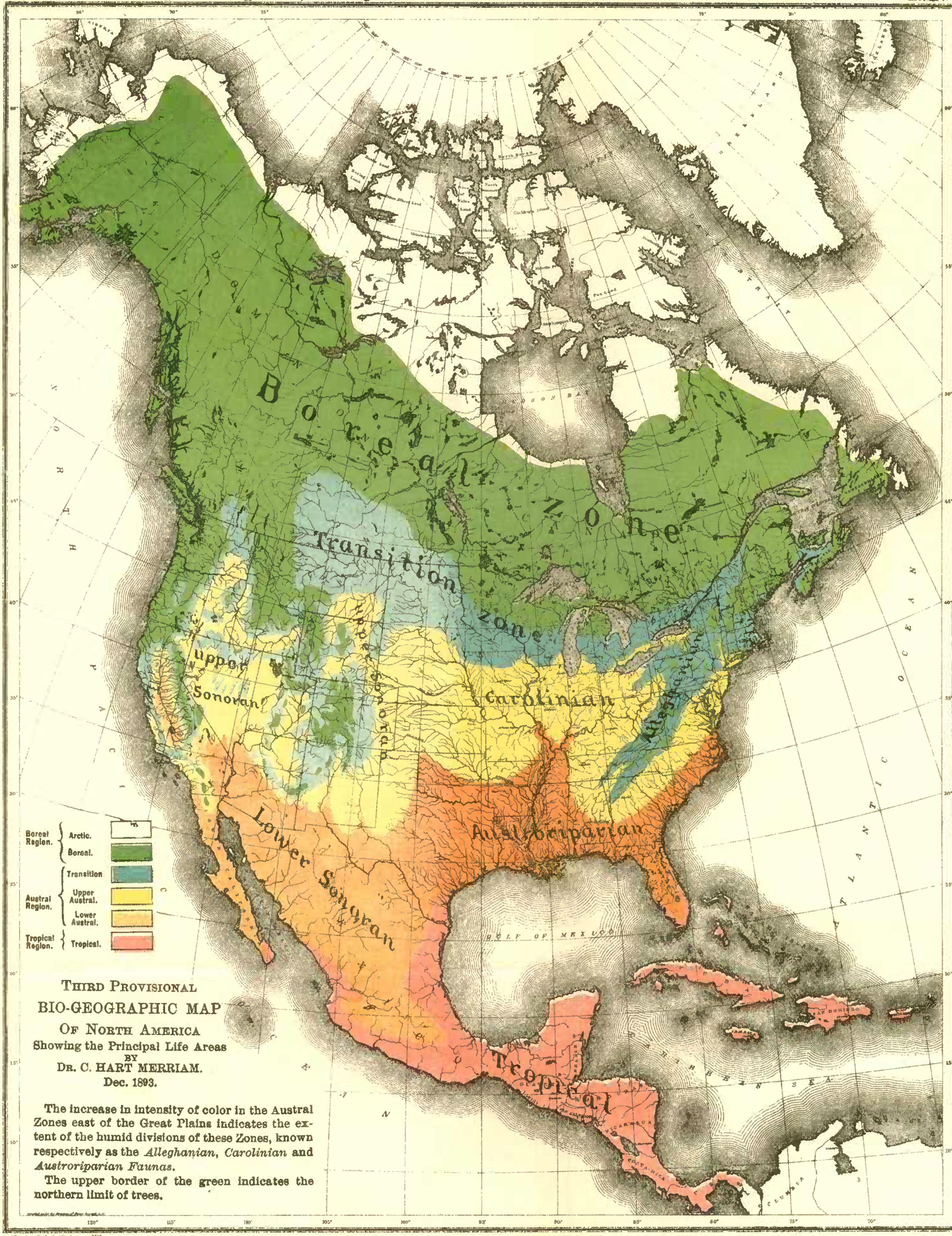
The number of life zones that have been defined in this country north of the tropical is six. They may be grouped under two heads: Northern or *Boreal* and southern or *Austral*. In Eastern North America these zones may be briefly characterized as follows, beginning at the north:*

(1) *Arctic or Arctic-Alpine Zone*, above the limit of tree growth; characterized by the Arctic poppy, dwarf willow, saxifrages, gentians, and many other plants, and by the snow bunting, snowy owl, white ptarmigan, polar bear, arctic fox, and barren-ground caribou or reindeer. This zone is of no agricultural importance.

(2) *Hudsonian Zone*, comprising the northern or higher parts of the great transcontinental coniferous forest—a forest of spruces and firs stretching from Labrador to Alaska. Among the numerous inhabitants of this zone are the wolverine, woodland caribou, moose, great northern shrike, pine bullfinch, crossbills, white-crowned sparrow, and fox sparrow. Like the last this zone is of no agricultural importance.

(3) *Canadian Zone*, comprising the southern or lower part of the great transcontinental coniferous forest, and inhabited by the porcupine, varying hare, red squirrel, white-throated sparrow, yellow-rumped warbler, and numerous others. Counting from the north, this zone is the first of any agricultural consequence. Here white potatoes, turnips, beets, the Oldberg apple, and the more hardy cereals may be cultivated with moderate success.

*On the accompanying map (Plate I) the two Boreal forest zones—the Hudsonian and Canadian—have not been separated but are shown together in green.



Sacher Lith. Co Rochester, NY

(4) *Transition Zone*, or belt in which the outlying Boreal and Austral elements overlap. Here the oak, hickory, chestnut, and walnut of the south meet the maple, beech, birch, and hemlock of the north. The same is true of mammals and birds, for here the southern mole and cottontail rabbit, the oriole, bluebird, catbird, thrasher, chewink, and wood thrush live in or near the haunts of the hermit and Wilson's thrushes, solitary vireo, bobolink, red squirrel, jumping mouse, chipmunk, and star-nosed mole. In this zone we enter the true agricultural part of our country; here the apple (Oldberg, Baldwin, Greening, Seek-no-further, and others), the blue plums, cherry, white potato, barley, and oats attain their highest perfection.

(5) *Carolinian Zone*, where the sassafras, tulip tree, hackberry, sweet gum, and persimmon first make their appearance, together with the opossum, gray fox, fox squirrels, cardinal bird, Carolina wren, tufted tit, yellow-breasted chat, and gnatcatcher. In this zone the Ben Davis and wine-sap apples, the peach, apricot, quince, sweet potato, tobacco, and the hardier grapes, such as the Concord, Catawba, and Isabella, reach their best condition.

(6) *Austroriparian Zone*, where the long-leaved pine, magnolia, and live oak are common on the uplands and the bald cypress and cane in the swamps. Here the mockingbird, painted bunting, red-cockaded woodpecker, and chuck-wills-widow are characteristic birds, and the cotton rats, ricefield rats, wood rats, little spotted skunks, and free-tailed bats abound. This is the zone of the cotton plant, sugar cane, rice, pecan, and peanut; of the oriental pears (LeConte and Kieffer), the scuppernong grape, and of the citrus fruits—the orange, lemon, lime, and shaddock. In its western continuation (the Lower Sonoran) the raisin grape, olive, and almond are among the most important agricultural products, and the fig ripens several crops each year.

Still further south is the *Tropical* region, which, in the United States, is restricted to southern Florida and extreme southeast Texas, along the lower Rio Grande and Gulf coast. Among the tropical trees that grow in southern Florida are the royal palm, Jamaica dogwood, machineel, mahogany, and mangrove; and among the birds may be mentioned the white-crowned pigeon, Zanaida dove, quail doves, Bahama vireo, Bahama honey-creeper, and caracara eagle. The banana, coacoanut, date palm, pineapple, mango, and cherimoyer thrive in this belt.

The Division of Ornithology and Mammalogy is engaged in tracing the courses of these various zones across the continent and in the preparation of large scale maps on which their boundaries are shown in different colors. These maps should be of value to the agriculturist in showing the position of his farm with reference to the life zone in which it lies, thus giving him a key to the crops most likely to succeed, for it has just been shown that the fauna and flora of a region may be made to serve as a reliable index to its agricultural capabilities. The further from the center of abundance a particular crop can be made to thrive the higher price it will command, always provided it is near a market. Hence the importance of utilizing the northern prolongations and islands of the southern zones and the southern prolongations and islands of the northern zones for the cultivation of agricultural products that otherwise must be transported considerable distances.

METHOD OF WORK.

The collection of data on the distribution of species was begun by the writer several years before the establishment of the division and

has been carried on almost continuously to the present time. Since the enlargement of the scope of the investigation, authorized by Congress in 1890, the work has been pressed with increased vigor and on a scale never before attempted. The aim from the first has been to obtain accurate and complete data for mapping the distribution of individual species, and at the same time, by combining these maps and by independent field work, to ascertain the boundaries of the natural life zones of the country.

In order to secure the utmost economy of time and labor in the preparation of these maps, the published information relating to each species and all manuscript records in the possession of the division are first carefully tabulated on schedules, care being taken to reject everything which is not entirely reliable. In mapping birds it is necessary to separate the records of the breeding ranges from those of the winter and migration ranges of each species. The localities tabulated on the schedules are transferred to large scale maps, each record on the schedule being indicated on the map by a red spot at the point where the species in question has been found. The area within the peripheral spots is then carefully colored by some one personally familiar with the topography of the region. Thus the map becomes a graphic representation of the schedule, and vice versa the latter may be regarded as an index to and authority for the map. This map now forms the basis of field investigations, the object of which is to trace out in greater detail the actual boundaries of the distribution of the species. By studying at one time the ranges of all the species inhabiting a given region the work is carried on rapidly and economically.

BIOLOGICAL SURVEYS.

In 1889 a system of biological surveys was begun for the purpose of mapping in detail the boundaries of the natural life zones of our country, at the same time securing data and specimens illustrating the distribution and status of the various species. The San Francisco Mountain plateau in northern Arizona was selected for work the first season (1889), and an area of some 12,000 square miles was mapped. In 1890 a reconnaissance was made of nearly 20,000 square miles in Idaho. In 1891 the Death Valley Expedition was engaged in similar work in the arid region of southern California and Nevada, and covered about 100,000 square miles between the Colorado River and the Pacific Ocean, connecting on the east with the field work of 1889. Thus, up to the beginning of 1892 there had been surveyed with more or less detail an area larger than the whole of New England, with New York and New Jersey added, or, approximately, equal to the States of Nebraska and Iowa combined.

A much larger area had been covered in a different way by field agents who have been engaged in securing data in various localities and in supplementing the work of the biological surveys.

The greatest drawback to the satisfactory completion of the biological maps is the lack of accurate topographic contour maps to serve as bases for plotting distribution. The map sheets of the U. S. Geological Survey, as far as published, have proved of the utmost assistance and value.

FIELD WORK IN 1893.

During the present year the biological survey of the Rocky Mountain region has been carried from Utah and Idaho completely across the

State of Wyoming, thus connecting the work of previous years in the Great Basin with the western part of the Great Plains. A large part of Wyoming was found to be from 1,000 to 3,000 feet lower than represented on the latest maps, and consequently to have a warmer summer climate and to belong to a more southern life zone than previously supposed. Thus the Wind River and Bighorn basins and the plains east of the Bighorn Mountains fall within the Upper Sonoran Zone instead of the Transition. This area is of considerable importance from an agricultural standpoint, from the fact that it marks the northern extension of the ranges of certain southern species of plants and animals. A special effort was made to determine the position of the boundary between the Upper Sonoran and Transition zones in the States of Nebraska, North and South Dakota, and Montana. Further south, field work was carried on in Kansas, Colorado, and New Mexico; and further west, in California, Nevada, and western Oregon.

The study of the faunal affinities and agricultural resources of the arid tropical and semitropical or Lower Sonoran zones on the table-land of Mexico has been continued during the year, with the result that material and data of great value have been accumulated which throw light upon problems presented in corresponding areas in the arid regions of the southwestern United States.

ECONOMIC RELATIONS.

Work under this head consists in the study of those habits of birds and mammals which have a direct bearing on agriculture, favorable or unfavorable, and in the preparation of the results for publication. Information is obtained mainly by the following methods: (1) By study of the habits of species in the field, both by the division staff and by voluntary agents; (2) by the examination in the laboratory of the contents of stomachs and crops, with a view to the accurate determination of the character of the food; (3) by study of the literature of the subject, which involves the collation of published notes from widely scattered sources.

Supplementary investigations and experiments frequently become necessary for the settlement of particular questions, such as the best methods of limiting or exterminating harmful species, or of protecting and encouraging those which are beneficial.

The bulletin on the common crow, announced last year as practically finished except for the report on the insect contents of the stomachs, was somewhat delayed by the receipt of several hundred additional stomachs, and still further by the fact that the entomologist's report on the insect food materially modified some of the conclusions, necessitating many changes in the text. It is now about ready for transmittal. This bulletin is based primarily on the examination of the stomachs of more than 900 crows, young and old, taken at all seasons of the year and from every section of the United States; and, in addition, contains summaries of the reports of several hundred correspondents, and a review of the published matter relating to the economic status of the crow. The percentage of each item of food has been determined and its importance estimated; and the insect food has been studied and reported on by specialists under the direction of the entomologist of the Department.

Good progress has been made on a similar bulletin relating to the crow blackbird, and more than 1,100 stomachs of that species have been examined. About 150 stomachs of other blackbirds were also exam-

ined, as well as 545 stomachs of woodpeckers, about 200 of the crow, and a few of other birds.* The total number of bird stomachs examined during the year is 2,064.†

The collection now numbers 20,102 stomachs, having been increased during the year by the addition of 3,900. This is not only the largest number added during any one year in the history of the division, but the stomachs are of unusual importance, being mainly those of the species directly affecting the interests of the agriculturist. The reference collection of seeds and other samples of bird food has also been materially increased.

EXHIBIT AT THE WORLD'S COLUMBIAN EXPOSITION.

Considerable time and labor were expended by the division in the preparation and installation of an exhibit for the World's Fair. The principal object in view was to show the character of the work in which this division is engaged. This was accomplished by graphic illustrations showing the geographic distribution of the mammals and birds in the United States and the economic status of the species. In the former line, the great fact that animals and plants are distributed in broad belts or zones, the boundaries of which are fixed primarily by temperature, was shown by means of three large models. One of these was a miniature mountain slope on which mounted specimens of characteristic mammals and birds were so assembled as to bring before the eye at a glance the successive faunas of different elevations. Another was a large topographic relief model of the area covered by the Death Valley Expedition. On this model, and on an adjoining relief map of the United States, the life zones were shown in different colors. The models were accompanied by enlarged photographs of desert scenery, with characteristic animals and plants. The subject was still further illustrated by maps of the United States, colored to show the areas inhabited by individual species and genera of mammals, birds, reptiles, and plants.

Groups of mammals and birds, beneficial and harmful, each handsomely mounted and surrounded by its accustomed food supply, constituted the exhibit which was designed to illustrate the economic relations of the species.

The importance of bird life to the farmer was further shown by an exhibit of the food of various species of birds, each item of which was carefully labeled. Groups of mounted hawks and owls in the act of killing or eating some animal habitually preyed upon, illustrated the gain or loss which each is likely to bring to the farmer. A series of stuffed skins of the birds, mice, squirrels, and other animals which have been found in the stomachs of various species showed interesting facts regarding the food habits of owls. These are but a few of the many novel features of the exhibit, which it is believed was both instructive and practical and justified the time devoted to its preparation.

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* One hundred and forty-five stomachs of the kingbird or bee martin were examined during the year, and the results, together with those obtained from twenty-five previous examinations, form the basis of a special paper on the food of the kingbird, an abstract of which accompanies this report.

† This determination of the food of species by examination of the stomach contents forms one of the most important features in the economic work of the division. Most of the errors due to ordinary observation are eliminated, and a foundation of actual facts is obtained which, in connection with competent field work, insures reliable conclusions.

FOOD HABITS OF THE KINGBIRD OR BEE MARTIN.

(*Tyrannus tyrannus.*)

By WALTER B. BARROWS.

The kingbird or bee martin is the largest common flycatcher in the United States, and is too well known to need any extended description. It is widely distributed during the breeding season, nesting abundantly in all the States east of the Rocky Mountains, and less commonly in Idaho, Utah, Washington, eastern Oregon, and northeastern California. It winter it migrates southward to the West Indies, Mexico, Central and South America, a few remaining along the Gulf coast and in southern Texas.

During its stay in the United States the kingbird feeds mainly on insects, which form at least 85 per cent of all its food from April to September.

The material available for a study of the food of this bird includes the published records by various naturalists of something less than fifty dissections made at different times during the last twenty years, to which are now added the results of the examination of 171 stomachs by specialists of this Department. These stomachs came from 19 different States, the District of Columbia, and Canada, and were collected during six months of the year. The preliminary examination was made by Prof. F. E. L. Beal, who estimated the percentage of vegetable and animal food and, with the assistance of the writer, made a provisional analysis of the insect material. Subsequently the entire insect material was submitted to the Division of Entomology, and the insects were carefully identified under the direction of Prof. C. V. Riley, mainly by Mr. Theodor Pergande and Mr. D. W. Coquillet. A careful examination shows beyond all question that the kingbird eats many more injurious insects than beneficial ones, and although it eats many predaceous insects such as dragon flies (*Neuroptera*) and Ichneumonid insects which are decidedly beneficial, yet these evils are far outweighed by the immense numbers of harmful insects regularly consumed.

Scarcely any trait of the kingbird is so well known, or at least so largely believed, as its fondness for honey bees, but the mere fact that the birds are seen lingering about the hives is not sufficient evidence that they are doing any harm to the bees. Many of our best naturalists have contended that the injury to beehives was too slight to deserve notice, and that the myriads of destructive insects which were eaten repaid the farmer or even the apiarist many times over. It has been noticed also that the bird appeared to prefer the drones. Among the 171 stomachs examined only 14, or less than one-twelfth of the entire number, contained any traces of the honey bee (*Apis mellifica*), while the total number of bees found was but 50; of these, 40 were positively identified as drones and only 4 were unquestionably workers. The remains of the other 6 were so fragmentary as to render impossible anything beyond the determination of the species. In several cases in which the birds had been shot near a hive no traces of bees were found in their stomachs. The results of these examinations show that not more than 1 kingbird in 12 catches honey bees, and that not more than 10 per cent of the insects caught are workers.

Among the enemies of the bee may be mentioned certain insects, notably the so-called robber flies belonging to the family *Asilidæ*, which do far more damage than birds. These robber flies are large, stout,

long-bodied flies, often covered with stiff hairs. According to Prof. C. V. Riley, one species (*Trupanea apivora*) has been known to kill 141 honey bees in a single day. In the stomachs examined by this Department not less than 6 kingbirds were found to have eaten these robber flies, and in one case at least 6 flies were found in a single stomach. It is very probable, therefore, that the killing of these robber flies would compensate for the 4 working bees, which were all we know to have been killed by the 171 kingbirds.

Although practically insectivorous, the kingbird has long been known to feed on fruits of various kinds. Among many hundreds of complaints received by the Department during the last seven years regarding the destruction of fruit by various birds, the kingbird has been mentioned as a fruit-eater in only three instances, when it has been accused of injuring cherries and small fruits. Nearly 50 per cent of the 171 stomachs examined contained vegetable food in amounts varying from a mere trace to 100 per cent, but only 2 contained vegetable matter alone. Of the total quantity of food eaten about 12 per cent was vegetable matter, probably all fruit; the remainder consisted entirely of insects, spiders, and myriapods. No less than 22 species of fruits have been identified in the stomach contents. Three stomachs out of 24, collected in May, contained vegetable matter, mainly remains of raspberries or blackberries. In the stomachs collected in June and July were found remains of cherries, mulberries, blueberries, and huckleberries, the average amount for the month of June being 4 per cent and for July 8 per cent. In August more than twice as much fruit was eaten as in July, the average for the former month reaching 22 per cent, although the relative number of stomachs containing fruit was slightly smaller than in July. The relative amount of fruit and insects found in the stomachs is shown in the following table:

Month.	Number of stomachs examined.	Number of stomachs containing—		Average percentage of food.	
		Insects.	Fruit.	Insects.	Fruit.
April	3	3	....	100	....
May	24	24	3	97·5	2·5
June	32	32	6	96	4
July	49	49	32	92	8
August	59	57	36	78	22
September	4	4	4	55	45
Total	171	169	81	88	12

REPORT OF THE BOTANIST.

SIR: I have the honor to submit herewith my report as Botanist of the U. S. Department of Agriculture for the period from March 8 to December 31, 1893.

Very respectfully,

FREDERICK V. COVILLE,
Botanist.

Hon. J. STERLING MORTON,
Secretary.

The former Botanist, Dr. George Vasey, was removed by death on the 4th day of March, 1893, after a period of twenty-one years' labor in the same official capacity. The untiring industry with which he devoted himself to his work can be appreciated best by reference to the résumés which were published in the Annual Reports of the Commissioner and later of the Secretary of Agriculture.

As partially indicative of the work accomplished by the Division of Botany before March 8, 1893, a list of its publications up to that date is here given. Prior to the year 1883 all official reports of the work of this division, like those of nearly all other branches of the Department, were published in the Annual Report of the Commissioner of Agriculture.

PUBLICATIONS PRIOR TO MARCH 8, 1893.

BULLETINS.

Bulletin No. 1. Report of an Investigation of the Grasses of the Arid Districts of Kansas, Nebraska, and Colorado. By George Vasey. 1886. 8°, pp. 19, 13 plates.

Bulletin No. 2. Report on the Fungous Diseases of the Grape Vine. By F. Lamson-Scribner. 1886. 8°, pp. 136, 7 plates.

Bulletin No. 3. Grasses of the South. A Report on Certain Grasses and Forage Plants for Cultivation in the South and Southwest. By George Vasey. 1887. 8°, pp. 63, 26 plates.

Bulletin No. 4. Desiderata of the Herbarium for North America North of Mexico. Ranunculaceæ to Rosaceæ, inclusive. By George Vasey. 1887. 8°, pp. 15.

Bulletin No. 5. Report on the Experiments made in 1887 in the Treatment of the Downy Mildew and the Black-rot of the Grape Vine; with a chapter on the Apparatus for Applying Remedies for these Diseases. By F. Lamson-Scribner. 1888. 8°, pp. 113; illustrated by figures in the text.

Bulletin No. 6. Grasses of the Arid Districts. Report of an Investigation of the Grasses of the Arid Districts of Texas, New Mexico, Arizona, Nevada, and Utah, in 1887. By George Vasey, S. M. Tracy, and G. C. Nealley. 1888, 8°, pp. 61, 30 plates.

Bulletin No. 7. Black-rot (*Læstadia Bidwellii*). By F. Lamson-Scribner and Pierre Viala. 1888. 8°, pp. 29, 1 plate.

Bulletin No. 8. A Record of some of the Work of the Division, including Extracts from Correspondence and other Communications. By George Vasey and B. T. Galloway. 1889. 8°, pp. 67.

Bulletin No. 9. Peach Yellows: A Preliminary Report. By Erwin F. Smith. 1888. 8°, pp. 254, 9 maps, 37 plates.

Bulletin No. 10. Report on the Experiments Made in 1888 in the Treatment of the Downy Mildew and Black-rot of the Grape Vine. By F. Lamson-Scribner, Alex. W. Pearson, H. L. Lyman, Hermann Jaeger, A. M. Howell, and M. Prillieux. 1889. 8°, pp. 61, 2 plates.

Bulletin No. 11. Report on the Experiments made in 1889 in the Treatment of the Fungous Diseases of Plants. By B. T. Galloway. 1890. 8°, pp. 119, 8 plates.

Bulletin No. 12.* Grasses of the Southwest. Plates and Descriptions of the Grasses of the Desert Region of Western Texas, New Mexico, Arizona, and Southern California. By George Vasey. Part I.—Issued October 13, 1890. Roy. 8°, pp. 107, 50 plates. Part II.—Issued December, 1891. Roy. 8°, pp. 108, 50 plates.

Bulletin No. 13.* Grasses of the Pacific Slope, Including Alaska and the Adjacent Islands. Plates and Descriptions of the Grasses of California, Oregon, Washington, and the Northwestern Coast, including Alaska. By George Vasey. Part I. Issued October 20, 1892. Roy. 8°, pp. 108, 50 plates.

Bulletin No. 14. Ilex Cassine, the Aboriginal North American Tea. Its History, Distribution, and Use among the Native North American Indians. By E. M. Hale, 1891. 8°, pp. 22, 1 plate.

CONTRIBUTIONS.

Contributions from the U. S. National Herbarium, Vol. I, No. 1. List of Plants Collected by Dr. Edward Palmer in 1888 in Southern California; by George Vasey and J. N. Rose. List of Plants Collected by Dr. Edward Palmer in 1889 at (1) Lagoon Head, (2) Cedros Island, (3) San Benito Island, (4) Guadalupe Island, (5) Head of the Gulf of California; by George Vasey and J. N. Rose. Issued June 13, 1890. 8°, pp. VIII, 1–28.

Contributions from the U. S. National Herbarium, Vol. I, No. 2. Upon a Collection of Plants made by Mr. G. C. Nealley in the Region of the Rio Grande, in Texas, from Brazos Santiago to El Paso County. By John M. Coulter. Issued June 28, 1890. 8°, pp. III, 29–61, index.

Contributions from the U. S. National Herbarium, Vol. I, No. 3. List of Plants Collected by Dr. Edward Palmer in Lower California and Western Mexico, at (1) La Paz, (2) San Pedro Martin Island, (3) Raza Island, (4) Santa Rosalia and Santa Agueda, (5) Guaymas. By George Vasey and J. N. Rose. Issued November 1, 1890. 8°, pp. III, 63-90, index.

Contributions from the U. S. National Herbarium, Vol. I, No. 4. List of Plants Collected by Dr. Edward Palmer in 1890 in Western Mexico and Arizona, at (1) Alamos, (2) Arizona. By J. N. Rose. Issued June 30, 1891. 8°, pp. III, 91-127, index, 10 plates.

Contributions from the U. S. National Herbarium. Vol. I, No. 5. List of Plants Collected by Dr. Edward Palmer in 1890 on Carmen Island. By J. N. Rose. List of Plants Collected by the U. S. S. *Albatross* in 1877–'91 along the Western Coast of America; by J. N. Rose, D. C. Eaton, J. W. Eckfeldt, and A. W. Evans. Revision of the North American species of Hoffmanseggia; by E. M. Fisher. Systematic and Alphabetic Index of New Species of North American Phanerogams and Pteridophytes, published in 1891; by Josephine A. Clark. Issued September 20, 1892. 8°. pp. V, 129–188, index, 5 plates.

Contributions from the U. S. National Herbarium, Vol. I, No. 6. List of Plants Collected by C. S. Sheldon and M. A. Carleton in the Indian Territory in 1891; by J. M. Holzinger. Observations of the Native Plants of Oklahoma Territory and Adjacent Districts, by M. A. Carleton. Issued December 6, 1892. 8°. pp. V, 189–232, index, 2 plates.

Contributions from the U. S. National Herbarium, Vol. II, No. 1. Manual of the Phanerogams and Pteridophytes of Western Texas. By John M. Coulter. Issued June 27, 1891. 8°, pp. V, and 1-152, index, 1 plate.

Contributions from the U. S. National Herbarium, Vol. II, No. 2. Manual of the Phanerogams and Pteridophytes of Western Texas. By John M. Coulter. Issued June 1, 1892. 8°, pp. V, 153–345, index, 2 plates.

Contributions from the U. S. National Herbarium, Vol. III, No. 1. Monograph of the Grasses of the United States and British America. By George Vasey. Issued February 25, 1892. 8°, pp. V, 1-89, index.

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* Extra editions of Bulletins Nos. 12 and 13 have been issued also as Volumes I and II of a work entitled, Illustrations of North American Grasses.

ANNUAL REPORTS.*

Report of the Botanist for the year 1886. By George Vasey. 1887. 8°, pp. 69–93, 21 plates.
Report of the Botanist for the year 1888. By George Vasey. 1889. 8°, pp. 305–324, 13 plates.
Report of the Botanist for the year 1889. By George Vasey. 1890. 8°, pp. 377–396, 11 plates.
Report of the Botanist for 1890. By George Vasey. 1891, 8°, pp. 375–392, 8 plates.
Report of the Botanist for 1891. By George Vasey. 1892. 8°, pp. 341–358, 10 plates.

MISCELLANEOUS.†

Special Report No. 63. The Grasses of the United States; being a Synopsis of the Tribes and Genera, with Descriptions of the Genera, and a List of the Species. By George Vasey. 1883. 8°, pp. 47.
The Agricultural Grasses of the United States; by George Vasey. The Chemical Composition of American Grasses; by Clifford Richardson. 1884. 8°, pp. 144, 120 plates.
A Descriptive Catalogue of the Grasses of the United States, including especially the Grass Collections at the New Orleans Exposition, made by the U. S. Department of Agriculture and the State Exhibits of Grasses, with notes on such species as are more or less employed in agriculture, or deserving of trial for cultivation. By George Vasey. 1885. 8°, pp. 110.
Special Bulletin. The Agricultural Grasses and Forage Plants of the United States, and such Foreign Kinds as have been Introduced, with an Appendix on the Chemical Composition of Grasses, by Clifford Richardson; and a Glossary of Terms used in Describing Grasses. A new, revised, and enlarged edition. By George Vasey. 1889, 8°, pp. 148. 114 plates.
Grass and Forage Experiment Station at Garden City, Kans. By J. A. Sewall. Coöperative Branch Stations in the South. By S. M. Tracy. 1892. Reprinted by authority of the Secretary of Agriculture from his Annual Report for 1891. 8°, pp. 12.

ORGANIZATION OF THE DIVISION.

The work of the Division of Botany as outlined by act of Congress is separable into two groups: (1) the investigation of forage plants, weeds, medicinal plants, and other subjects in economic botany; (2), the custody of a collection of plants of the United States, and to some extent of other countries, and continued additions to it. The subjects mentioned under the first group are so nearly representative, in a particular line, of the whole work of the Department that the method of their execution requires no especial explanation. But the treatment of the plant collections, in view, on the one hand, of their necessity in the work of the Department, and on the other hand, of the large dimensions which they have assumed and the increased expenditure which they might entail, if not properly managed, is a subject which requires more careful consideration.

THE HERBARIUM.

With regard to the nature of these collections it may be said briefly that they contain series of the plants brought back from nearly all the transcontinental surveys from the time of Nicollet and Fremont onward, and from United States Government expeditions to the Arctic regions, to South America, to Africa, and to the islands of the Pacific, together with sets obtained from many recent collectors in the newer parts of our own country, many miscellaneous donations of amateur or

* No separate editions of the annual report of the Botanist were issued prior to the one for 1886, nor for the year 1887, but they may be found in the Annual Reports of the Commissioner of Agriculture.

† These few reports, prepared by the officers of the Division of Botany, have been published, not in the regular series issued by that division, but as isolated publications or in general series of the Department.

professional botanists, and several important collections received from the Government herbaria of foreign countries.

The Department of Agriculture can not, on the one hand, dispense with the use of these collections, nor should it, on the other hand, support a botanical museum which shall be unlimited in scope and erratic in development—a subject, consequently, for the loose expenditure of uncertain and perhaps extraordinary amounts of money. Having these facts in view, the Botanist has presented a plan designed to satisfy the conditions of the case. The main features of this plan are, (1) to properly house, protect, and arrange the collections; (2) to make provision for their normal and healthy growth along well-defined lines; (3) to develop the collections in their economic aspects.

NEED OF MORE COMMODIOUS QUARTERS.

The plan in question, as presented in a letter from the Botanist to the Secretary of Agriculture, dated November 8, 1893, is essentially as follows:

In view of the present pressing need in the Department of Agriculture for more commodious quarters, I desire to submit an outline plan to relieve the congested condition of the main building, and to provide fireproof quarters for valuable property.

There are in constant use in the Division of Botany collections and books which have been in process of accumulation from the time of the earliest transcontinental surveys, and in which are represented the natural vegetable resources of the country. These collections and books are under constant liability to destruction by fire, and in the event of such a deplorable accident could never be entirely replaced. Nor could they, I estimate, be brought again to their present level of value for less than $150,000.

The Division of Botany is earnestly desirous of making use of these materials to increase the directly practical features of its work, and the moderate enlargement of its quarters preliminary to this line of development has already become a difficult problem under the present conditions.

One of the deficiencies most keenly felt at present by the Division of Botany is the lack of a sufficient library. A nucleus of a good botanical library already exists in the Department, and an examination of several of the larger libraries in Washington has disclosed an additional number of works devoted to botany, the use of many of which could without doubt be had by the Department of Agriculture under proper provisions for safe-keeping. In the present overcrowded and unsafe condition of the division the Botanist has not thought it advisable to request the loan of such books. The Department of Agriculture should have a library in which accurate information regarding the vegetable resources of the world would be at all times accessible, but at present its library is deplorably deficient in this class of books.

To bring about the desired result I would urge that steps be taken at an early date to secure a suitable building. Since the style of this building, and therefore the cost, must be decided in part by the requirements of the case, and in part by the financial exigencies of the Department, two general plans may be considered. First, a building may be erected which shall provide fireproof quarters for the herbarium and the offices of the Division of Botany, plain in design, but sufficiently commodious to satisfy immediate necessities. Such a building can probably be erected for $25,000. On the other hand, if it is considered desirable to provide permanently for the herbarium and the work connected with it, a larger building more nearly perfect in its equipment and of a design architecturally suitable to the Department grounds should be planned. This building might at first be used to good advantage to house also one or more of the other divisions whose work is closely related to that of the Division of Botany. Without having made a detailed plan for such a structure, I estimate that it can be properly built and equipped for $100,000, and that $5,000 properly expended would bring the botanical library to a high standard of usefulness.

As a final means for defining the relations of these botanical collections, emphasizing their character as a national institution, and providing for their sound administration, the passage of a law containing the following provisions is advocated:

Definition of the National Herbarium.

(1) That the name United States National Herbarium shall be a general designation for all botanical collections, consisting of dried plants mounted or in condition for mounting, seeds, fruits, and other vegetable products, or representations of them, illustrating the uses of plants or the principles of the science of botany, which are now in the custody of the Department of Agriculture, in charge of the Botanist of said Department, or which may hereafter, in accordance with the provisions of this bill, be added to these collections.

Custody of the National Herbarium.

(2) That the National Herbarium shall be in the custody of the Department of Agriculture, and the Botanist of said Department shall be *ex officio* curator of said herbarium, to have charge of the collections, under the direction of the Secretary of Agriculture, and to be responsible for their management.

Additions to the National Herbarium.

(3) That in addition to the customary methods of accession by gift, deposit, loan, or purchase, any collection of plant products belonging to the United States may, with the consent of the chief officer of that branch of the Government in whose custody it is, be received as an addition to and thus become a part of the National Herbarium.

Establishment of sectional collections.

(4) That whenever in any branch of the Government necessity shall arise for the use of a special portion of the National Herbarium, such portion may be transferred as a sectional collection to such branch of the Government: *Provided,* That a guaranty of the proper safe-keeping of such sectional collection be given, and that said collection be subject to recall at any time.

Appointment of the Botanist.

(5) That the Botanist of the Department of Agriculture shall be appointed by the Secretary of Agriculture, the nomination being made by a board consisting of the president of the Civil Service Commission, the secretary of the Smithsonian Insititution, and the president of the National Academy of Sciences: *Provided,* That the Secretary of Agriculture may reject any nomination and that the rights of said Secretary to dismiss the Botanist or to call for his resignation be not restricted.

It is believed that by the adoption of a course similar to that here indicated, an establishment may be perfected within two or three years, clearly defined in its relations and objects, well administered and fruitful in its results, and that the current expenses, unless a large amount of additional work is attempted, will not exceed the present appropriation.

In the course above outlined for the treatment of the Department's botanical collections the Botanist has already received the general approval of the Secretary and Assistant Secretary of Agriculture, and although the condition of the national finances at the present time prevents any recommendation for the required appropriation, it is hoped that the wisdom of this plan may so appeal to Congress as to receive from that body ultimately the funds necessary to carry it out.

FORAGE EXPERIMENTS AT GARDEN CITY, KANS.

In the year 1888, 240 acres of land 2 miles from Garden City, Kans., were secured by the U. S. Department of Agriculture on a free five-years' lease, to be used for forage experiments. The primary object of these experiments was to ascertain whether any crops other than those at that time under cultivation in the southern Great Plains (which in dry years were almost utter failures) could be grown in that region successfully without irrigation. Reports of the progress of these experiments have been made annually by the Botanist; those for the first year unfavorable, for the second, third, and fourth years promising increasingly gratifying results.

On the 31st day of October of the present year, according to previous

arrangement, the experiment farm at Garden City was formally closed, the personal property of the Department in use there having been previously advertised and sold at public auction.

The greatest importance of the results attained during this five-years' experiment lies not more in the fact that certain forage plants have been found which produce uniformly in western Kansas a good crop of hay, than in the fact that a general method of cultivation in such subarid regions has been brought out and the fundamental reasons for the method have been ascertained. These results may, therefore, be taken as a sound basis for similar experiments on forage plants in other parts of the western United States in which similar conditions exist. Following is a brief account of the method recommended for producing a forage crop without irrigation in western Kansas.

PREPARATION OF THE SOIL.

The ground should be plowed to a depth of 12 inches and broken up as much as possible with a common harrow. The soil should next be pulverized by the use of a fine-toothed harrow constructed especially for that purpose. The following directions for making such a harrow are given by Dr. J. A. Sewall, superintendent of the farm:

> Take four oak planks, each 10 feet long, 10 inches wide, and 2 inches thick. Into each of these planks drive 400 40-penny wire nails, arranging them in 4 rows 3 inches apart, the nails also 3 inches apart in each row and projecting to a distance of 3 inches from the under side of the plank. Fasten the 4 planks together by strong iron strap hinges, bolted on. Two clevises for attaching the whipple-trees are then bolted into the edge of the forward plank and the harrow is ready for use.

The harrow here described requires four horses. A smaller one might be constructed on the same plan to be drawn by two horses, but it is probable that the expense of doing the same work with the smaller harrow would in the end be greater. The cost of this fine-toothed harrow, exclusive of labor in putting it together, is about $6.

As a final preparation before seeding, the plowed, harrowed, and fine-harrowed ground should be thoroughly rolled and the upper surface loosened again by the fine-toothed harrow. The ground is now well prepared for the seed.

The essential points in this method of soil preparation are deep plowing, pulverizing the soil by the harrow, and heavy rolling. These principles are based both on a knowledge of the practical outcome of their application and upon actual experimental measurement of the amount of water thus held in the soil, for the retention of moisture in the ground until it can be used gradually by the growing crop is the important object gained by this method of soil preparation. In all future experimentation in the growth of nonirrigated crops in the subarid lands the same object should be kept prominently in mind.

One important fact must be mentioned here, namely, that after the ground is plowed the harrowing and rolling, and if possible the seeding also, should be completed with the greatest dispatch possible, since during these processes the loose condition of the upturned soil permits an unusually rapid evaporation of the moisture which it contains. The exact time of plowing is a question which must depend upon the careful judgment of the farmer himself, keeping in mind on the one hand the proper time for planting his crops and on the other hand the condition of the ground itself for plowing. In these regions of irregularly timed rainfall the soil may remain for several weeks at a time too dry to be plowed, and even if it could be reduced to the desired fineness no ordinary seed would germinate in it.

As an illustration of the value of the method of soil preparation described above may be cited an experiment made by Dr. Sewall in 1892. An acre of new land was plowed to the depth of 4 inches and given an ordinary harrowing. This ground was sowed to red Texas oats, a crop tested during that season on soil which had been deeply plowed, finely harrowed, and rolled. The result was that on the ground of ordinary tillage 18 bushels of grain (by weight at 32 pounds per bushel) were produced per acre; on that prepared by the special method employed at the farm 82·7 bushels per acre. There is no doubt whatever that by a proper method of manipulating the soil of subarid lands their productiveness may be remarkably increased.

THE BEST NONIRRIGATED FORAGE PLANTS FOR WESTERN KANSAS.

The necessary steps preliminary to planting the crop have already been described, and these steps are essentially the same for all the crops experimentally cultivated at Garden City. The next important consideration is that of the choice of seed, and in this respect also the experiments have been decisive. Four plants have been found well adapted to cultivation for forage in this region without irrigation, as follows:

RED KAFFIR CORN.—This is one of the varieties of sorghum (*Sorghum vulgare*) which, instead of developing a large, sugar-producing stem, grows principally into leaves. The seed should be planted in drills during the last week of May or the first week of June, the drills 3½ feet apart and the seeds about 6 inches distant in each drill. The crop should be cultivated not with a plow but with a small fine-toothed harrow constructed after the manner of the large one previously described. This red Kaffir corn commonly produces a crop of 5 to 7 tons of dry fodder per acre, which is greedily eaten by stock, and is by many considered superior in feeding value to alfalfa.

HUNGARIAN BROME (*Bromus inermis*).—Of the grasses proper this species, which has long been cultivated on the dry plains of Southeastern Europe, has proved best adapted to the subarid region of western Kansas. It is a perennial, forming a permanent meadow, producing commonly 1½ to 3 tons of hay per acre. The present season was an unprecedentedly dry one, only 9 inches of rain having fallen up to September 1. Of this only 3 inches fell before the middle of July, a period of more than six months, and on no one day did the rainfall exceed 0·7 inch, an amount soon evaporated from the surface of the soil and of no essential value to a growing crop. Under such adverse conditions a field of Hungarian brome on the 1st of July had produced a scant growth of blades about 6 inches long, when even the native buffalo grass of the surrounding country was as brown and dry as if dead. Following the rains of late July the Hungarian brome produced a crop of about 1 ton of hay per acre. The present season, it must be remembered, was the driest ever known in western Kansas, and the ability of Hungarian brome to produce a crop under the most adverse climatic conditions is therefore assured.

NATIVE GRASSES.—Two native grasses, switch grass (*Panicum virgatum*) and Colorado blue-stem (*Agropyrum glaucum*), have also been found successful, though to a less marked degree than Hungarian brome.

JERUSALEM CORN.—As an accessory of the forage experiments, a test has been made of the grains best adapted to the same region, with the result that one of the varieties of sorghum, known as Jerusalem corn, has been found a valuable crop. It produces 20 to 40 bushels of

threshed grain per acre, having almost the same feeding properties as maize. While there is at the present time no general market for this grain, its local value as human food and for feeding hogs, horses, and cattle is highly important, especially in a dry season like the present when the wheat and corn crops in western Kansas were total failures.

GRASSES FOR THE SOUTH.

In the year 1888 a series of forage experiments was inaugurated by the U. S. Department of Agriculture, in collaboration with the Mississippi Agricultural Experiment Station, for the purpose of improving the forage product of the southern United States. During the few years following, coöperative experiments were begun at the stations in North Carolina, Georgia, Florida, and Louisiana, all under the supervision of Prof. S. M. Tracy, of Mississippi. A report on these experiments, prepared by Prof. Tracy and submitted to the Botanist, will be transmitted for publication at an early date.

This report states that 508 species have been tried experimentally and about 35 have been found successful. For the purposes of practical agriculture, however, about a dozen of these species will fill the customary needs of the South as far as meadows and summer pastures are concerned. The lowland region of the Southern States is divided into 4 types, based upon the characters of the soil as employed for agricultural purposes, namely, the yellow loam soil, alluvial bottom lands, black prairie soil, and pine woods soil. Prof. Tracy has given an account of the forage crops best adapted to each of these soils and the best fertilizers to be used, statements which his careful study of these two questions and his long and practical experience with the needs of the region make authoritative.

As emphasizing the value of these experiments, and as indicative of the manner in which the South has taken up the cultivation of the best forage plants, the statement may be made that the census returns for 1880 show that in the five States in which these experiments have been conducted the yield of hay was 0·86 ton per acre, as compared with an average of 1·14 tons for the whole United States. The report of the Division of Statistics for November, 1893, shows that during that season these five States had increased their yield to 1·66 tons per acre, while the average for the entire country was 1·32 tons.

GINSENG CULTURE.

The commercial utilization of many of the natural plant products of the United States is a subject brought constantly to the attention of the Division of Botany by innumerable letters and specimens from all parts of the country, with questions regarding the value and uses of certain native species. In pursuance of a general plan to definitely ascertain the real utility, or to increase the already ascertained utility, of some of these products, and in order to have actual data for answering authoritatively many inquiries on a particular one of these subjects, namely, ginseng culture, arrangements have been made for collating and digesting all the available information on the cultivation of that plant. The market value of the dried root among wholesale purchasers is from $2.50 to $4 per pound, and its rapid exportation to the Chinese market is exhausting the limited natural supply.

MEDICINAL PLANTS.

The question of employing our native medicinal plants as remedies in disease has been for several years a subject of general consideration by the Division of Botany. It is believed that the manner in which this division can add new and valuable facts to our pharmacopœia in regard to the increased employment of our native plants in medicine lies in ascertaining by actual analysis the constituents of certain plants reputed to have medicinal properties and in testing these constituents by physiological experiment.

By coöperation with the Bureau of Animal Industry such an analysis of one of our common Western plants in popular use as a febrifuge has been made, and an alkaloid discovered which will be submitted to physiological tests. The value of a single medicinal product brought to light by this method will be far greater and more definite than the description of any number of medicinal plants the knowledge of whose properties is based on popular repute merely.

RUSSIAN THISTLE.

The Russian thistle (*Salsoli kali tragus*) still continues to alarm the farmers of North and South Dakota, and is rapidly spreading over wider areas. In response to numerous inquiries and complaints regarding the amount of damage caused by it in the infested area, Mr. L. H. Dewey, assistant botanist, was again detailed in November of the present year to visit the States in which it has become firmly established and to make a report thereon. This report is nearly completed, and will be transmitted for publication in time for use during the coming season.

In addition to the facts published last year in the Annual Report and in Farmers' Bulletin No. 10, the edition of which was long since exhausted, it is ascertained this year that the plant has already covered an area of about 30,000 square miles in the States of North Dakota, South Dakota, Minnesota, Wisconsin, Iowa, Nebraska, Kansas, and Wyoming, and the damage caused by it during the present season is estimated at from $3,000,000 to $5,000,000. The nature of the weed is such that its progress can not be stopped by any means except concerted action against it. There is no doubt whatever that the plant will spread throughout the whole Great Plains region and still farther east, infesting a large part of the wheat-producing region of the United States. The steps to prevent this, if any are to be undertaken, should be begun at once.

PURE SEED.

A matter which has demanded the attention of national agricultural institutions of other countries, and the results of which have proved of the greatest benefit to the farmer, is some system of seed inspection, not necessarily mandatory, but advisory in its powers. With a view to ascertain the purity of the seed distributed by the U. S. Department of Agriculture, arrangements have been made for the establishment of a seed collection in the Division of Botany, in which shall ultimately be represented all our cultivated plants and all our weeds. It is proposed that with this collection as a basis, and with the work of European seed-control stations as a precedent, the Department of Agriculture shall undertake before the close of the coming year to make preliminary analyses of the seed distributed. The necessity and

the value of such seed inspection need not be discussed here, since they are both well known to those actively interested in important agricultural questions in the United States, and it is appropriate that a movement of this kind should originate at the U. S. Department of Agriculture, which has been for many years a source of governmental distribution of seeds for agricultural purposes.

Other reasons have also accentuated the demand for an authentically determined collection of seeds in the Division of Botany, especially the necessity for accurate identification of the seeds which are of importance in connection with the food habits of birds and insects.

By direction of the Secretary of Agriculture a civil-service examination has already been held for the purpose of selecting a person suitable to take charge of this work, and an appointment is now promised at an early date.

PUBLICATIONS OF THE YEAR.

The following publications have been issued by the Division of Botany during the year 1893:

Farmers' Bulletin No. 10. The Russian Thistle and Other Troublesome Weeds in the Wheat Region of Minnesota and North and South Dakota. By L. H. Dewey. 1893. 8°, pp. 18, 2 plates.

Bulletin No. 13. Grasses of the Pacific Slope, including Alaska and the Adjacent Islands. Plates and descriptions of the grasses of California, Oregon, Washington, and the Northwestern Coast, including Alaska. By George Vasey. Part II. Issued June 1, 1893. Roy. 8°, pp. 108, 50 plates.

Report of the Botanist for 1892. By George Vasey. 1893. 8°, pp. 201-214, 9 plates.

Contributions from the U. S. National Herbarium, Vol. I, No. 7. Systematic and Alphabetic Index to New Species of North American Phaneregams and Pteridophytes published in 1892; by Josephine A. Clark; issued July 15, 1893. 8°, pp. III, 233-264, index.

Contributions from the U. S. National Herbarium, Vol. I, No. 8. Notes on some Pacific Coast Grasses, by George Vasey; Descriptions of New or Noteworthy Grasses from the United States, by George Vasey; Descriptions of New Grasses from Mexico, by George Vasey; Descriptions of New Plants from Texas and Colorado, by J. M. Holzinger; List of Plants New to Florida, by J. M. Holzinger; descriptions of Three New Plants, by J. N. Rose; List of Lichens from California and Mexico, Collected by Dr. Edward Palmer from 1888 to 1892, by J. W. Eckfeldt. Issued October 31, 1893. 8°, pp. III, 265-262, index, 5 plates.

Contributions from the U. S. National Herbarium, Vol. IV. Botany of the Death Valley Expedition. A Report on the Botany of the Expedition sent out in 1891 by the U. S. Department of Agriculture to make a Biological Survey of the Region of Death Valley, California. By Frederick Vernon Coville. Issued November 29, 1893. 8°, pp. VIII, 363, 21 plates and frontispiece.

RECOMMENDATIONS.

In addition to the new work already undertaken by the Division of Botany, it is desirable that other problems in economic botany should receive immediate attention. One of the most important of these is a continuation of the forage experiment work in the South and the West. While for certain areas and in certain directions of improvement the experiments are already conclusive, so far as the Department of Agriculture is concerned, it is eminently desirable that similar experiments be tried on new areas, and that additional lines of investigation be taken up. The Botanist will submit at an early date a general plan for the development of this work along two lines: (1) The preparation of publications which shall present an accurate scientific knowledge of our forage plants; (2) the conducting of experiments which shall aim to place in an immediately available form the best practical knowledge attainable on the cultivation and commercial value of these plants in directions other than those already investigated by the Department of Agriculture.

REPORT OF THE CHIEF OF THE DIVISION OF VEGETABLE PATHOLOGY.

SIR: I have the honor to submit herewith my annual report for the year 1893, embodying a brief summary of the more important investigations of the Division of Vegetable Pathology.

Very respectfully,

B. T. GALLOWAY,
Chief.

Hon. J. STERLING MORTON,
Secretary.

INTRODUCTION.

Since the last report my assistant, Mr. D. G. Fairchild, has resigned to go abroad to study, and his place has been filled by the appointment of Mr. Albert F. Woods, of Nebraska. With this exception the scientific corps of the division remains practically the same as last year.

Realizing the importance of keeping the assistants thoroughly interested in their work, it has always been my policy to give them every facility for carrying on their investigations and then allowing them to publish the results of their labors as a contribution to the literature issued by the division. In this way the men are kept thoroughly in sympathy with the work, and as a result it is not a question with them of putting in a certain number of hours each day, but it is how to make the most of every available hour of the twenty-four. The strongest endeavor is made to imbue every man with the importance of making his work as practical as possible. To do this he must himself be thoroughly familiar with practical agricultural and horticultural methods, and this familiarity is gained only by work in the field and association with practical men.

In considering this subject there is no intention to underestimate the necessity and importance of thorough scientific work. Such work must be done; in fact it is the foundation upon which all other labors rest. However, it does not necessarily have to be brought prominently forward in dealing with the farmer. He cares little about the details of such work; therefore, so far as he is concerned, everything that has no apparent practical bearing on matters of interest to him may as well be eliminated.

With these introductory remarks the principal matters which have occupied the attention of the division during the year may now be briefly reviewed.

PUBLICATIONS.

During the year the division has issued one number of the Journal of Mycology; Bulletin No. 4, on experiments with fertilizers for the prevention and cure of peach yellows; and Circular No. 13, on leaf curl of the peach. It has now in press Bulletin No. 5, on experiments in the pollination of pear flowers; and in manuscript, ready for publication, Bulletin No. 6, a report on the chemistry, toxicology, and fungicidal value of Bordeaux mixture.

The number of the Journal issued contains papers on the following subjects: Experiments made in the treatment of rusts affecting wheat and other cereals, The peach rosette, Prevention of a fungous disease affecting the leaves of almond trees in California, Prevention of leaf diseases in the nursery, Destruction of lichens on pear trees, etc. The index to literature on plant diseases also forms a part of the Journal, 348 foreign and domestic papers being briefly reviewed. Bulletin No. 4 embodies the results of four years' work with fertilizers to determine their value as a preventive or cure for peach yellows. The bulletin, it is believed, shows conclusively that the disease in question can not be prevented or cured by fertilization of the soil. Circular No. 13 was designed to obtain information on peach leaf curl, a disease which annually causes considerable damage in this country. It is believed that a remedy for the disease has been discovered, and to obtain facts that will enable us to test the remedy on an extensive scale was the main object of the circular.

FURTHER INVESTIGATIONS INTO THE CAUSES AFFECTING THE FRUITFULNESS OF PEAR AND APPLE TREES.

In the last annual report* of this division the work on pollination of pear and apple blossoms was briefly reviewed. The work, it was shown, was undertaken by a member of this division while he was engaged upon some investigations of pear blight, especially the relation of insects to the disease. It was found that when insects were excluded from the flowers of pears and apples many varieties failed to set fruit. Further investigations and experiments brought out the important fact that the majority of varieties of the fruits in question were incapable of self-fertilization. The practical bearing of this discovery was important, as it threw considerable light on causes affecting the fruitfulness of orchards, causes which had long been little understood. Further experiments during the past year have fully verified the results announced in my last report. In addition, the work has shown that even with the Kieffer pear, which is mostly self-fertile, a decided increase in fruit was apparent when pollen of a different variety was used in fertilizing the flowers. It was also observed that the Oriental varieties behaved like the ordinary European ones; that is, they gave better results with cross-pollen than with their own pollen. In the case of apples few fruits were found to set when self-pollinated, but the cross-pollinations were very successful. The quince, however, appears to be capable of self-fertilization. In some cases there is an advantage in cross-pollinations, but the results are contradictory and apparently individual.

As a result of the entire work it may be said that the fruiting of a pear or apple tree is controlled by a number of influences, and while these are complicated they should not be looked upon from a single

*Report of the Secretary of Agriculture, 1892, pp. 241–243.

point of view. The question of cross-fertilization is important, but it is only one of a number of factors which determine the fruitfulness of a tree.

Vigor of growth is one of the factors to be considered. A tree in good condition is able to set and develop its fruits even when not wholly adapted to self-fertilization, while, on the contrary, deficiency of vigor will frequently render the tree at first completely self-sterile, and then, if carried too far, sterile to cross-pollination. So, too, the weather conditions during flowering time have considerable effect. It is, of course, well known that for all plants there are certain maximum and minimum temperatures beyond which they will not thrive. This is the case with pears. Suitable weather is a potent factor in fruitfulness, however, even in those areas where good results are obtainable. Warm, sunny weather at flowering time is best, and the more such days there are the better. Cold, rainy weather is detrimental, chilling the flowers and causing the pollen to fall. This last fact was well shown in an experiment with a Mount Vernon pear tree made at Geneva, N. Y. This tree was sprayed continuously for eight days, the entire time of blooming, and not only was no fruit set, but the foliage was rendered sickly and the tree's condition greatly impaired.

Another factor to be considered in fruitfulness, so far as cross-pollination is concerned, is the time the varieties bloom. It is obvious that no benefit will arise from proximity when two distinct varieties are too far separated in their time of blooming, and this must be considered in planting any two varieties for crossing. In the North the principal varieties generally bloom well together and there is considerable latitude allowed in choosing, but in the South there is sometimes an interval of several days or even weeks between the blossoming period of two varieties. For example, along the James River in Virginia it is found that Le Conte and Kieffer bloom a week ahead of the Angoulême, and that the Bartlett is two or three days later still. In southern Georgia the Le Conte blooms from three to five weeks before the Kieffer. The importance, therefore, of mixing several varieties in the same orchard, so that if one blooms too early another may serve, or if one does not bloom at all another may, is sufficiently apparent.

Insect visitors are of course the important adjuncts for cross-fertilization. It has been found that at least fifty species of insects visit the flowers of the pear. The common honey bee is perhaps more important than any other, although various species of sweat bees are of great service. The weather conditions react upon the insects, and cool weather is detrimental to their activity and usefulness. Naturally fungous and other diseases affecting the blossoms and general health of the trees play an important part in any consideration of fruitfulness.

ORCHARD WORK IN THE TREATMENT OF PEAR LEAF-BLIGHT.

During the year two series of experiments in the treatment of pear leaf-blight (*Entomosporium maculatum*) were carried on in the orchard of the Old Dominion Fruit Company, located on the James River, near Scotland, Va. This work was in charge of Mr. Waite, a member of the division, and for convenience it will be discussed under two heads: (1) An experiment to determine the least number of treatments with Bordeaux mixture necessary to prevent leaf-blight, and the best time for making the applications; (2) an experiment to ascertain the actual cost of treating the orchard as a whole four times with Bordeaux mixture, using every effort consistent with efficacy to cheapen the work.

In this case the work was wholly at the expense of the owners of the orchard.

The trees, consisting of about 19,000 Bartletts, were 19 years old, and, excepting leaf-blight, which every year had caused a loss of the greater part of the foliage, were comparatively free from disease. The fact that the trees had been regularly defoliated made the orchard an excellent place for the experiment. The Bordeaux mixture used was the so-called 50-gallon formula, consisting of 6 pounds of copper sulphate and 4 pounds of lime to 50 gallons of water.

For experiment 1 a portion of the orchard where the trees were uniform was selected and divided into 8 plats of 20 trees each, the same being treated as hereinafter described. Each plat consisted of two rows of 10 trees each. For controls or checks, plats of the same size as those treated were left at the end of each block and between each treated plat. Finally, all the plats were duplicated, thus making the experiment as a whole include 640 trees. The treated plats were sprayed as follows: Plat 1, treated once, April 24; plat 2, treated once, May 1; plat 3, treated once, May 15; plat 4, treated once, June 1; plat 5, treated twice, May 1 and 15; plat 6, treated three times, May 1 and 15 and June 13; plat 7, treated four times, May 1 and 15 and June 1 and 15.

At the time of the first treatment the earliest developed leaves had just reached full size and no leaf-blight whatever had appeared. The orchard was visited on August 2 and October 12, careful notes being made on the condition of the trees at the time of each visit. On August 2 it was found that the control or untreated trees had lost the greater part of their foliage; at that time only about one-fifth of the leaves remained on the trees and these were rapidly falling, being badly affected with leaf-blight. All the sprayed trees were in excellent condition at this time, excepting those on the plat sprayed once on April 24. The trees on this plat were badly diseased, in most cases less than half of the foliage remaining.

Without going into further details in regard to this work the results may be briefly summarized as follows: (1) The earliest treatments had the least effect in preventing leaf-blight, and of the single treatments there was an increase in effectiveness up to June 1; that is, the treatment on May 1 gave better results than the one on April 24, while that on May 15 gave still better results than either of the preceding. (2) The two sprayings, either on May 1 and May 15, or May 1 and June 1, for all practical purposes proved as efficient as any made.

The observations made as the work progressed seemed to clearly indicate that the leaf-blight fungus does not commence its work early in the season. It develops first on the foliage when the latter is about full grown, and rapidly increases in virulence as the summer advances, assuming its maximum development after August 1. From the data at hand it would appear that to obtain the best results in the treatment of the disease in question at the least expense, two applications of Bordeaux mixture should be made, the first between May 15 and June 1, or from four to six weeks after the trees blossom, and the second one month later. How far this method is applicable to other sections of the country has not been determined, but in view of the fact that the fungus is quite regular in its appearance, it is probable that the recommendations here made will apply to nearly all regions where the disease occurs. The experiments, however, should be repeated one or two seasons in different localities in order to get conclusive results.

In experiment 2, in the treatment of the orchard as a whole, every effort was put forth to reduce to a minimum the cost of the work. Four applications of the Bordeaux mixture were made, the first on April 24, and the others thereafter at intervals of about twelve days. In order to save time in preparing the mixture, a stock solution of the copper sulphate was prepared and the lime was also made up in advance. (For directions see p. 264.) A barrel holding 50 gallons was selected, and in it 100 pounds of copper sulphate were dissolved.

Two spraying outfits were used, each consisting of a hogshead holding 150 gallons, mounted upon a wagon. To the hogshead was attached a Nixon No. 3 double-acting force pump, provided with two discharge hose, each 20 feet long. At the end of each hose was a brass tube 6 feet long, provided with a stopcock and Vermorel nozzle. It required three men to operate the apparatus, one to drive and pump and two to manage the nozzles, the latter being done while standing on the ground. In operating the machine it was found necessary to stop only a few seconds in order for each man, one on each side of the wagon, to spray a tree. Most of the work was done while the team was moving slowly along between the trees. It required twelve days to spray the entire orchard; thus, as soon as the last trees were finished work would immediately begin on those first sprayed. Working as described, the total cost of making the four applications to about 16,000 trees was as follows:

Labor of 1 white man 48 days, at $1.25 per day	$60
Labor of 5 colored men 48 days, at 75 cents per day	180
Work of 2 teams, with wagons, 48 days, at $2 each per day	192
Total cost of labor	432
Chemicals, copper sulphate and lime	70
Wear and tear on sprayers	20
Total	522
Cost of four treatments per tree ... cents	03.2
Cost of one treatment per tree ... do	00.8

It appears from the foregoing that standard trees 19 years old may be treated four times with Bordeaux mixture at an expense of a little over 3 cents per tree. Furthermore, it appears that the principal item of cost was for labor. Had the facts brought out by experiment 1 been known, viz, that two sprayings are as useful as four, the cost of the work would have been reduced one-half. The cost of the fungicide being such a relatively small matter, it seems that in the future efforts should be made looking toward improving the means of distributing rather than cheapening the liquid.

EXPERIMENTS IN THE TREATMENT OF BLACK ROT OF THE GRAPE.

A TEST OF BORDEAUX MIXTURE OF VARIOUS STRENGTHS.

Bordeaux mixture has come to be generally regarded as the best fungicide known for black rot of the grape. Since it was first used in this country efforts have been made to reduce its strength, with various degrees of success. To obtain some additional facts as to how far the mixture might be weakened without materially affecting its efficacy, an experiment was carried on the past season in the vineyard of Mr. J. A.

Svedberg, at Sterling, Va. Twelve different strengths of the mixture were used, the three strongest being as follows:

Copper sulphate	kilograms 3, or pounds 6·6
Lime	kilograms 2, or pounds 4·4
Water	liters 100, or gallons 26·4

Each formula was reduced one-twelfth and made up in 8 liters or practically 2-gallon quantities. Following are the proportions of copper sulphate, lime, and water as finally adopted:

Formula.	Copper sulphate.	Lime.	Water.	Copper sulphate.	Lime.	Water.
	Grams.	*Grams.*	*Liters.*	*Ounces.*	*Ounces.*	*Pints.*
1	240	160·60	8	8·46	5·64	16·905
2	220	146·72	8	7·76	5·15	16·905
3	200	133·12	8	7·04	4·69	16·905
4	180	120·00	8	6·34	4·23	16·905
5	160	106·88	8	5·64	3·77	16·905
6	140	93·60	8	4·92	3·30	16·905
7	120	80·00	8	4·23	2·81	16·905
8	100	70·64	8	3·52	2·50	16·905
9	80	53·76	8	2·81	1·89	16·905
10	60	40·00	8	2·12	1·40	16·905
11	40	27·20	8	1·40	0·96	16·905
12	20	13·92	8	0·70	0·48	16·905

It will be seen from the foregoing figures that the mixture varied in strength from 8·4 ounces of copper sulphate and 5·6 ounces of lime to 2 gallons of water, to 0·7 of an ounce of copper sulphate and 0·48 of an ounce of lime to 2 gallons of water. The formulas for the most part were weaker than any heretofore used, and for this reason their effects were watched with special interest. The vines selected for the work were Concords, and were used last year in an experiment to test the value of a number of new and old fungicides as preventives of black rot. The block consisted of 25 rows with 8 vines in a row, making 200 vines in all. Each short row of 8 vines constituted a plat, the first being untreated, the next treated with No. 1 or the strongest formula, the next untreated, and the next treated with formula No. 2, and so on, the treated and untreated plats alternating. The vines were 9 years old and for the past three years had set a fair crop of fruit. They were trained to stakes, thus making it somewhat difficult to spray the inside leaves and fruit. The treatment began on May 11, the mixture being applied with a Japy pump and Vermorel nozzle. It was planned to make the applications every ten days, but the weather and other conditions made it necessary to slightly modify this arrangement.

At the time of the first spraying the vines were in good condition, the young shoots being from 2 to 9 inches long and containing 2 to 4 leaves one-half to two-thirds grown. Four additional treatments were made, namely, on May 20, and June 1, 13, and 29, respectively. Owing to a severe drought, which prevailed the remainder of the season, no further treatments were made. From time to time a careful examination was made of each plat, and a record kept of the amount of rot present, the effect of the mixtures on the foliage, fruit, etc., and other points of interest. Finally, when the fruit was fully ripe it was gathered, the yield of each vine being kept separate. As heretofore, three divisions were made of the fruit, (1) perfect clusters, containing 1 to 5 rotten berries; (2) part perfect clusters, containing 6 to 10 rotten berries; and (3) worthless clusters, containing 11 or more rotten berries. Without entering into details in regard to the various points brought out from time to time as the experiment progressed, it may be said in conclu-

sion that all the formulas were remarkably effective in preventing the attacks of black rot.

The data obtained as a result of counting the clusters, as already explained, showed the difference in the effectiveness of the various formulas to be so slight as to be hardly worthy of notice. Thus, plat No. 2, treated with the strongest formula, gave of perfect clusters 100 per cent; plat No. 4 gave 99·9 per cent; and the others, 99·3, 97·8, 100, 100, 100, 99·4, 99, 99·2, and 93·4 per cent, respectively. In other words, when the grapes were fully ripe every cluster on plat No. 2 was found perfect, while plat No. 4 gave 99·9 per cent of perfect bunches, and so on down the list. Comparing the number of perfect clusters on the treated vines with those on the untreated, we find the difference most striking. Thus, plat No. 1 gave only 17·4 per cent of perfect clusters as compared with 100 per cent on the treated plat No. 2; plat No. 3 gave 55·8 per cent of perfect clusters; while plats 5, 7, 9, 11, 13, 15, 17, 19, 21, and 23, all untreated, gave 38, 40, 49·3, 53·1, 29·1, 12·6, 40, 29, 25·9, and 15·7 per cent of perfect clusters, respectively.

The results, while not conclusive, for the reason that they are based upon one season's work, certainly point to the fact that the strength of the mixture can be very materially reduced without affecting its efficiency. This is in line with previous experiments made by the division, as well as the experience of a number of grape-growers in different parts of the country.

To test the matter on a more extended scale, it is planned to spray during the coming season an acre or more of vines with at least three of the formulas given. The strongest and weakest formulas will be used, and also a formula representing the mean. The cost of the three preparations in 100-gallon quantities is, approximately, $1.08, 63 cents, and 9 cents, in the order of their strengths.

OTHER EXPERIMENTS IN THE TREATMENT OF BLACK ROT.

In addition to the experiments briefly outlined under the preceding heading, several other lines of work were carried on in Mr. Svedberg's vineyard. Briefly, these experiments were designed to throw light on the following questions:

(1) The value of flowers of sulphur and sulphosteatite as preventives of black rot, as compared with Bordeaux mixture, standard strength.

(2) The effect, so far as injury to the foliage and fruit was concerned, of applying the powders in the middle of the day and during hot sunshine as compared with their application early in the morning when the dew was on the vines. It was found last year that both powders mentioned severely injured the foliage and fruit when applied in the middle of the day.

(3) The value of applying Bordeaux mixture to the ground directly beneath the vine.

(4) The effect of spraying with Bordeaux mixture five times, beginning with the standard formula* and doubling the quantity of water, or decreasing the strength one-half at each succeeding application.

With regard to the results of this work, it may be said that while the powders to a certain extent prevented rot, the effects produced by them in this respect were not nearly so marked as with Bordeaux mixture. The time of day for applying the powders made little difference,

* Six pounds of copper sulphate, 4 pounds of lime, and 45 gallons of water.

so far as injury to the vines was concerned. Altogether it may be said that for this section neither sulphur nor sulphosteatite can compare with Bordeaux mixture as a preventive of black rot. Besides their inefficiency as fungicides and their injurious effects on the leaves, fruit, and wood, there are other objections to their use which make them undesirable.

Spraying the ground beneath the vines with Bordeaux mixture, as might be expected, produced no effect, so far as concerns the prevention of black rot. Every grape on these vines rotted, while those immediately adjacent, sprayed with Bordeaux mixture, matured in almost perfect condition fully 90 per cent of the crop which set.

It could not be determined from the most careful observations that reducing the formula of the Bordeaux mixture at each application materially altered its efficacy as a preventive of black rot. These results are in line with those given under the preceding heading, but, as there pointed out, they should not be accepted as conclusive.

TREATMENT OF LEAF DISEASES AFFECTING NURSERY STOCK.

The experiments in the treatment of diseases affecting nursery stock, begun in 1891 at Mullikin, Md., were concluded during the year. As already pointed out,* this work was designed primarily to test the effect on growth of preventing by means of fungicides various leaf diseases. As planned and carried out, the work began with the seedling or cutting and was kept up each season until the budded tree was of salable size. Incidentally, it was intended that the work should also throw some light on the relative value of different stocks so far as their resistance to different diseases was concerned. Something over 6,000 pear, quince, apple, and plum trees were used in the experiment, and from the beginning to the end of the work a careful record of the growth and general condition of each tree with respect to disease or diseases was made. It is not practicable to give here even a summary of the results, as this would necessitate going into details in regard to the work. It may be said, however, that of the several fungicides used Bordeaux mixture produced the best effects. In many cases, especially with pears, spraying three seasons with this preparation resulted in a growth from two to three times greater than where the trees received no treatment at all. In other words, the sprayed trees, according to the grading adopted by nurserymen, were worth from two to three times as much as the unsprayed. Taking into consideration the total cost of the treatments, it was found that the work yields a very handsome profit. It is hoped that full details of the experiment may be ready for publication at an early day.

ADDITIONAL EXPERIMENTS IN THE TREATMENT OF WHEAT RUST.

In the report for 1892 a summary was given of a series of experiments carried on in Maryland and Kansas for the purpose of obtaining some definite information in regard to the possibility of preventing rust of wheat and other cereals. The principal objects of the work were (1) to determine, with respect to rust, the effect on winter wheat of treating the soil with various chemicals before planting the grain; (2) to deter-

* Bulletin No. 3, Division of Vegetable Pathology, 1892, p. 48.

mine the effect of treating the seed with chemicals and with hot water previous to planting; (3) to determine the effect on the plants of spraying at different times with various fungicides. As a result of this work, it was shown that treating the soil and seed had no effect whatever, so far as the prevention of rust was concerned. Furthermore, the data at hand seemed to indicate that in some cases spraying diminished the amount of rust and apparently increased the yield of both grain and straw.

In view of the fact that the fungicides which gave the best results in 1891-'92 were less than one-tenth normal strength, and for other reasons, it was thought desirable to repeat certain parts of the work in 1892-'93, with such modifications as previous experience had suggested. As spraying the plants during the fall and winter in the first experiment had no apparent effect so far as rust was concerned, it was decided not to begin the treatments until spring, starting the work in one case as soon as growth commenced and in another postponing the first spraying until rust actually appeared.

Only three fungicides were used, namely, Bordeaux mixture; ammoniacal solution of copper carbonate; and copper sulphate, ammonia, and soap mixture. The fungicides were of two strengths, normal and half, the former being the recognized standard preparation, as described in previous reports and given below, and the latter, as the name implies, half the standard strength. Soap was added to some of the fungicides and some were applied without the addition of this substance. As pointed out in my last report, the addition of soap was found to greatly increase the wetting power of the liquids, and to determine whether this affected the efficiency of the latter the soap was in some cases added and in some omitted. The experiments, therefore, may be divided into nine series, as follows:

(1) Treatment with Bordeaux mixture, normal strength, i. e., 6 pounds of copper sulphate, 4 pounds of lime, and 45 gallons of water, with soap.

(2) Treatment with Bordeaux mixture, normal strength, without soap.

(3) Treatment with Bordeaux mixture, half strength, i. e., 6 pounds of copper sulphate, 4 pounds of lime, and 90 gallons of water, with soap.

(4) Treatment with Bordeaux mixture, half strength, without soap.

(5) Treatment with ammoniacal solution, normal strength, i. e., 5 ounces of copper carbonate dissolved in 3 pints of ammonia, diluted with 45 gallons of water, and soap added.

(6) Treatment with ammoniacal solution of copper carbonate, normal strength, without soap.

(7) Treatment with ammoniacal solution of copper carbonate, half strength, i. e., 5 ounces of copper carbonate, 3 pints of ammonia, and 90 gallons of water, with soap added.

(8) Treatment with ammoniacal solution of copper carbonate, half strength, without soap.

(9) Treatment with copper sulphate, ammonia, and soap mixture, containing copper sulphate 4·20 ounces, ammonia 0·211 ounce, soap 8·28 ounces, and water 8 gallons.

The experiments were conducted at Garrett Park, Md., on the same ground used for the work in 1891-'92. After cutting the wheat in 1892 a crop of potatoes was planted. These were dug in October, and after plowing and harrowing the ground the wheat was sown at the rate of 1½ bushels per acre by means of an ordinary 2-horse drill. No fertilizer was used excepting what was drilled in with the potatoes, and which had a material effect on the latter crop, as will be shown later. When the wheat was 2 inches high the entire block was divided into 56 equal-sized plats, each plat being 10 by 50 feet, making the area 500 square feet. The plats were arranged in two parallel rows, with a 4-foot walk between each row. Separating each plat was a 2½-foot

walk. Each treatment was made in duplicate, the original and duplicate plats being separated as far as possible in order to obtain different soil conditions. Sprayings were made every eight days, starting in one series when the growth of the young plants first commenced in spring and in another as soon as rust appeared.

From time to time during the winter the plats were carefully examined, but no rust or other disease worthy of mention appeared. From the start, however, there was a marked difference between the plants in the rows formerly occupied by the potatoes and those between such rows. Growth was very much stronger in the former case, owing to the action of the fertilizer used, as already pointed out. The uneven growth of the plants, however, in no way affected the experiments, as the fertilized strips crossed all the plats in the same manner and in equal number, thus practically making all uniform in this respect.

The first spraying of all the plats designed to receive the early treatment, i. e., treatment from the time spring growth started until harvest, was made on April 14. The plants at this time had just started into growth, those in the potato rows being from 4 to 6 inches high, and those between the rows 2 to 4 inches high.

Owing to the difficulty experienced in dissolving lard soap, and also on account of the cost of the latter, it was decided to try whale-oil soap as a substitute. Accordingly, this material was added to each of the fungicides until their wetting power was about the same as when lard soap was used. Such large quantities of the whale-oil soap, however, were necessary to produce the desired effect that its use was abandoned and a high quality of lard soap adopted for the rest of the season.* The lard soap greatly increased the wetting power of the fungicides, but still it was found very difficult to satisfactorily cover the foliage. Using a knapsack pump and Vermorel nozzle, it required about seven minutes to spray each original and duplicate plat containing 1,000 square feet, 3 gallons of liquid being required for the work. On this estimate, allowing for time gained in filling the machine and in other ways, one man could probably spray an acre in about four hours, and would use something like 129 gallons of liquid. The wheat at this time did not average more than 3½ inches in height.

On April 22 the second treatment was made, and on carefully examining the plants it was found that many of them had been seriously injured by the previous spraying with Bordeaux mixture and ammoniacal solution, combined with whale-oil soap. This would seem to indicate that either the soap itself had caused the injury or its addition to the fungicides had resulted in the formation of injurious compounds. Some recent experiments have shown that the latter assumption is probably true.

The third treatment was made on May 1, at which time the plants in the fertilized rows were from 7 to 12 inches high, while those between the rows and unfertilized were only 4 to 6 inches in height. The general condition of all the plats was practically the same, no rust or other disease having as yet made its appearance. Without going into further details, which will be published in full elsewhere,† it may be said that five treatments were made in addition to those already given,

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* See Report of the Secretary of Agriculture, 1892, p. 220, for description of method employed in using soap. A more detailed account is given in the Journal of Mycology, Vol. VII, No. 3.

†A detailed paper will probably appear in the Journal of Mycology, Vol. VII, No. 4.

making eight in all. The dates for the additional treatments were May 9, 17, and 26, and June 7 and 14, respectively. Rust was first found on May 9 on a bunch of self-seeded wheat, a few yards from the first plats. The bunch contained 71 stalks and averaged 22 inches in height.

On May 14 rust was found for the first time on one of the regular plats, the sori appearing very sparingly on the oldest leaves. The fungus was about one week later this year than last, but the wheat itself and in fact all vegetation at this time was about seven days later than the preceding year. During the two seasons in which these experiments have been carried on the young plants have been watched very carefully, and while no actual rust sori, or sori containing mature spores, have been found in the fall or early spring, pale yellowish spots on the leaves have been seen, and upon microscopic examination these are found to be due to the mycelium of the rust fungus. It appears, therefore, that in this climate the fungus frequently infects the young plants in the fall, and after remaining more or less dormant in the tissues during the winter, starts into growth early in the spring and develops its first uredospores during the latter part of April and early part of May. Whether these spores alone are responsible for the general infection and spread of the fungus which follows, or whether the latter is brought about by other means, are questions which yet remain unsettled. Certain it is that the fungus first appears in isolated spots on the leaves formed the previous autumn, and that it apparently spreads from these centers to all parts of the field.

Another interesting feature of the question is found in the fact, already pointed out,* that the plant must reach a certain age before rust develops to any great extent upon it. Thus this year rust first appeared on self-seeded plants fully ten days before it was observed on the hand-seeded plants. There was at least ten days or two weeks difference in the age of this wheat and that sown and platted. It is believed it may safely be said that for this section and within certain limits, of course, the earlier winter wheat is sown the sooner will it show rust the following spring. The time of sowing does not seem to materially influence the amount of rust in the end, for if two plats of wheat are planted two weeks apart they will both show practically the same amount of rust at harvest.

At the time of the sixth treatment, May 26, rust was to be seen in considerable quantity on all the plats. Careful estimates showed that the treated plats were considerably less affected than the untreated, but as the season advanced this difference became less and less marked.

On June 5, at the time of the seventh treatment, 25 plants were selected promiscuously from each plat, and after a careful examination of each plant it was placed in one of the following grades: (1) Slightly rusted (plants showing only comparatively few sori here and there on the lower leaves); (2) badly rusted (plants having one-half to two-thirds of the leaves affected and showing sori plainly on nearly all of the leaves); (3) very badly rusted (plants having all of the leaves affected, the sori being more or less abundant on each leaf).

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* Journal of Mycology, Vol. VII, No. 3, p. 208.

The result of this grading, which involved a very careful examination of 950 plants, is set forth in the following table:

Results of grading treated and untreated plants affected with rust.

No. of plat.	Kind of treatment.	Number of plants rusted.			Total number of plants rusted.	Per cent of plants rusted.		
		Slightly.	Badly.	Very badly.		Slightly.	Badly.	Very badly.
1	Sprayed with Bordeaux mixture, normal strength, with soap, every 8 days, beginning in early spring*	1	6	13	20	5	30	65
42	......do	12	8	5	25	48	32	20
2	Untreated	1	10	14	25	4	40	56
43	......do	7	12	6	25	28	48	24
3	Sprayed with Bordeaux mixture, normal strength, with soap, every 8 days, beginning at first appearance of rust	13	12	......	25	52	48	......
44	......do	7	12	6	25	28	48	24
4	Untreated	......	15	10	25	......	60	40
45	......do	5	13	7	25	20	52	28
5	Sprayed with ammoniacal solution, normal strength, with soap, every 8 days, beginning in early spring	19	6	......	25	76	24	......
46	......do	16	9	......	25	64	36	......
6	Untreated	6	9	10	25	24	36	40
47	......do	5	14	6	25	20	56	24
7	Sprayed with ammoniacal solution, normal strength, with soap, every 8 days, beginning at first appearance of rust	17	7	1	25	68	28	4
48	......do	22	3	......	25	88	12	......
8	Untreated	10	7	8	25	40	28	32
49	......do	3	13	9	25	12	52	36
9	Sprayed with copper sulphate, ammonia, and soap mixture every 8 days, beginning in early spring	22	3	......	25	88	12	......
50	......do	20	4	1	25	80	16	4
10	Untreated	6	7	12	25	24	28	48
51	......do	4	9	12	25	16	36	48
11	Sprayed with cupric sulphate, ammonia, and soap mixture every 8 days, beginning at first appearance of rust	11	11	3	25	44	44	12
52	......do	22	3	......	25	88	12	......
12	Untreated	3	9	13	25	12	36	52
53	......do	......	9	16	25	......	36	64
13	Sprayed with Bordeaux mixture, normal strength, without soap, every 8 days, beginning in early spring	15	8	2	25	60	32	8
54	......do	17	8	......	25	68	32	......
14	Untreated	......	13	12	25	......	52	48
55	......do	6	11	8	25	24	44	32
15	Sprayed with Bordeaux mixture, normal strength, without soap, every 8 days, beginning at first appearance of rust	8	15	2	25	32	60	8
56	......do	13	12	......	25	52	48	......
16	Untreated	6	8	11	25	24	32	44
29	......do	2	9	14	25	8	36	56
17	Sprayed with ammoniacal solution, normal strength, without soap, every 8 days, beginning in early spring	8	16	1	25	32	64	4
30	......do	14	11	......	25	56	44	......
18	Untreated	5	9	11	25	20	36	44
31	......do	1	12	12	25	4	48	48
19	Sprayed with ammoniacal solution, normal strength, without soap, every 8 days, beginning at first appearance of rust	8	14	3	25	32	56	12
32	......do	11	10	4	25	44	40	16

* Five plants showed no rust.

As will be seen from the above table, every plant selected, with the exception of 5 from plat 1, was more or less affected with rust. The per cent of plants that were rusted slightly, badly, and very badly on both treated and untreated plats averaged 37, 38, and 25, respectively. The components of these averages were 29, 19, and 5 on the treated

plats, and 8, 19, and 20 on the untreated, showing a considerable decrease in the amount of rust present in favor of the treated plats.

The plats which showed the least amount of rust (9 and 50) were the 2 sprayed with the copper sulphate, ammonia, and soap mixture. Out of the 50 plants selected from these plats, only 1 was very badly rusted and 7 badly rusted, while 42 showed very little rust. This could scarcely be due to soil conditions, as the control plats (10 and 51) showed an unusually large amount of rust, 24 of the 50 plants selected from these plats being very badly rusted, 16 badly rusted, and only 10 slightly affected.

It appears, therefore, that up to the time the plants were collected, namely, on June 5, or about three weeks before harvest, the treatments aided materially in holding the rust fungus in check. Furthermore, it appears that the best results were obtained from the use of the copper sulphate, ammonia, and soap mixture.

From May 26 until June 26, at which latter date the wheat was harvested, rust rapidly increased on all the plats. After harvesting and shocking in the usual manner the grain was rubbed out by hand and weighed, the yield of each plat being kept separate. The weight of straw was also determined, and from these weighings the data set forth in the table below were obtained:

Yield of treated and untreated plats.

No. of plat.	Kind of treatment.	Yield of grain.		Yield of straw.		Total yield of grain and straw.		Yield of grain per acre.		Yield of straw per acre.
		Lbs.	*Oz.*	*Lbs.*	*Oz.*	*Lbs.*	*Oz.*	*Bu.*	*Lbs.*	*Pounds.*
1	Sprayed with Bordeaux mixture, normal strength, with soap, every 8 days, beginning in early spring	7	1	30	1	38	0	10	15	2,695
42	......do	7	9	26	9	34	2	10	58	2,316
2	Untreated	4	7	24	15	29	6	6	26	2,175
43	......do	7	14	27	3	35	1	11	28	2,368
3	Sprayed with Bordeaux mixture, normal strength, with soap, every 8 days, beginning at first appearance of rust	8	10	32	3	40	13	12	31	2,804
44	......do	9	8	30	13	40	5	13	47	2,684
4	Untreated	7	4	25	12	33	0	10	31	2,243
45	......do	8	2	26	0	34	2	11	47	2,265
5	Sprayed with ammoniacal solution, normal strength, with soap, every 8 days, beginning in early spring	7	1	25	13	32	14	10	15	2,248
46	......do	8	15	27	5	36	4	13	1	2,379
6	Untreated	6	13	25	0	31	13	9	53	2,178
47	......do	10	6	26	10	37	0	15	3	2,319
7	Sprayed with ammoniacal solution, normal strength, with soap, every 8 days, beginning at first appearance of rust	6	5	27	3	33	8	9	9	2,368
48	......do	9	9	24	15	34	8	13	53	2,175
8	Untreated	6	4	29	3	35	8	9	7	2,545
49	......do	9	1	23	3	32	4	13	9	2,022
9	Sprayed with copper sulphate, ammonia, and soap mixture (soap eau celeste), every 8 days, beginning in early spring	9	7	31	1	40	9	13	44	2,708
50	......do	10	5	24	15	35	5	15	1	2,175
10	Untreated	7	3	27	12	34	15	10	26	2,420
51	......do	8	13	23	14	32	11	12	50	2,079
11	Sprayed with copper sulphate, ammonia, and soap mixture (soap eau celeste), every 8 days, beginning at first appearance of rust	9	10	29	1	38	11	13	58	2,531
52	......do	9	1	23	2	32	3	13	9	2,014
12	Untreated	7	12	28	11	36	7	11	17	2,499
53	......do	8	6	21	1	29	7	12	12	1,837
13	Sprayed with Bordeaux mixture, normal strength, without soap, every 8 days, beginning in early spring	10	15	34	8	45	7	15	52	3,005

Yield of treated and untreated plats—Continued.

No. of plat.	Kind of treatment.	Yield of grain.	Yield of straw.	Total yield of grain and straw.	Yield of grain per acre.	Yield of straw per acre.
		Lbs. Oz.	*Lbs. Oz.*	*Lbs. Oz.*	*Bu. Lbs.*	*Pounds.*
54	Sprayed with Bordeaux mixture, normal strength, without soap, every 8 days, beginning in early spring	9 3	24 14	34 1	13 20	2,169
14	Untreated	8 8	30 6	38 14	12 20	2,646
55	......do	10 7	26 12	37 3	15 9	2,330
15	Sprayed with Bordeaux mixture, normal strength, without soap, every 8 days, beginning at first appearance of rust	12 7	35 10	48 1	18 3	3,106
56	......do	6 2	18 4	24 6	8 53	1,589
16	Untreated	9 9	32 13	42 6	13 53	2,858
29	......do	6 9	25 8	32 1	9 31	2,221
17	Sprayed with ammoniacal solution, normal strength, without soap, every 8 days, beginning in early spring	9 3	30 0	39 3	13 23	2,613
30	......do	6 15	25 12	32 11	10 4	2,246
18	Untreated	7 4	24 9	31 13	10 31	2,142
31	......do	6 7	25 3	31 10	9 20	2,194
19	Sprayed with ammoniacal solution, normal strength, without soap, every 8 days, beginning at first appearance of rust	7 12	25 8	33 4	11 15	2,224
32	......do	8 7	27 3	35 10	12 17	2,363

The above table shows a considerable increase in the amount of both grain and straw on the treated over the untreated plats, the yield of the former averaging 8·7 pounds of grain and 28 pounds of straw, while on the latter the yield was 7·8 pounds of grain and 26·3 pounds of straw. Spraying with ammoniacal solution (normal strength) and soap produced no beneficial effect; in fact the plats treated in this way (7 and 48) yielded slightly less grain and almost exactly the same amount of straw as the corresponding untreated plats (8 and 49). It would appear that spraying with Bordeaux mixture without soap had the effect of materially increasing the proportion of straw. The plats receiving this treatment (13 and 54) produced several pounds more straw than any other plats in the series. This may have been accidental, however; at any rate further experiments are necessary in order to settle the question. The most successful treatment seemed to be with the copper sulphate, ammonia, and soap mixture. The plats treated with this preparation produced the largest yield of any in the series.

Taking everything into consideration, it is believed the facts at hand warrant the statement that spraying with fungicides will, to a certain extent, prevent rust of cereals, but the work can not be done on a paying basis. This was practically the conclusion reached last year, and, as pointed out then,* we should look to other means of preventing the losses occasioned by the rust fungi, such as the breeding of rust-resisting varieties and the improvement of cultural methods.

POTATO DISEASES.†

During the past two years attention has been directed to certain diseases of the potato. This work has been carried on during the press of other studies, and while not complete, it is believed sufficient facts have accumulated to warrant a review of the investigations.

The principal malady considered is one to which the name Macrosporium potato disease has been given. It was first observed about

* Journal of Mycology, Vol. VII, No. 3, p. 225.

† A paper embodying the facts set forth in regard to the Macrosporium disease was read at the Madison meeting of the Society for the Promotion of Agricultural Science, August, 1893.

eight years ago in Missouri, and has since been frequently called to the attention of the division. The disease has undoubtedly long been confounded with the well-known blight or rot, caused by the fungus *Phytophthora infestans.* From observations made in various parts of the country it was suspected that the latter fungus did not cause the destruction generally attributed to it. To obtain some reliable information on this point and to determine at the same time as accurately as possible the distribution of the Macrosporium disease, a circular letter was sent out early in August, 1892. One hundred and fifty copies of this were sent to reliable men in 25 different States, a special effort being made to reach all sections and also different parts of the various States. This letter described briefly the Macrosporium disease, and called special attention to the manner in which it differed from the true blight caused by *Phytophthora infestans.*

The questions asked were: (1) Does the disease occur in your region? (2) If present, what per cent of the crop is destroyed by it? (3) At what period of growth are the plants usually attacked? A request was also made that specimens be sent for examination. Of the 110 replies received 60 stated that their sections were free from the disease, 39 complained of it, and 11 were indefinite in their answers. Thirty-three specimens were received, and 32 of these showed the Macrosporium and no other fungus, while only 1, from New Hampshire, showed *Phytophthora infestans.* The following table is a summary of the information gathered in this way:

Summary of replies relative to potato diseases.

State.	Number of circulars sent.	Number of replies received.	Nature of reply.			Number of specimens sent.	Number affected by—	
			Affirmative.	Negative.	Indefinite.		*Macrosporium solani.*	*Phytophthora infestans.*
California	5	5	1	4	0			
Connecticut	5	3	2	0	1	1	1	
Illinois	10	9	1	8	0	1	1	
Indiana	5	2	0	2	0			
Iowa	5	4	3	1	0	2	2	
Kansas	5	3	1	2	0	1	1	
Kentucky	5	3	0	3	0			
Maine	5	3	3	0	0	2	2	
Maryland	5	4	1	2	1	1	1	
Massachusetts	5	3	1	2	0	1	1	
Michigan	10	6	1	3	2	1	2	
Missouri	5	2	0	2	0			
Nebraska	5	5	0	3	2			
New Hampshire	5	4	1	2	1			1
New Jersey	5	4	3	1	0	3	3	
New York	10	9	8	1	0	8	7	
Ohio	10	6	3	2	1	2	2	
Oregon	5	4	0	4	0			
Pennsylvania	10	9	5	3	1	4	4	
Tennessee	5	4	1	3	0			
Vermont	5	3	3	0	0	5	4	
Virginia	5	3	0	2	1			
Washington	5	5	1	3	1	1	1	
West Virginia	5	3	0	3	0			
Wisconsin	5	4	0	4	0			
Total	150	110	39	60	11	33	32	1

From these data it appears that the Macrosporium disease is widely distributed, but that it is less abundant in the far West and in the South than in other sections. The loss is estimated by different growers at from 10 to 75 per cent.

To supplement this information letters were sent to various botanists all over the country, mostly connected with experiment stations, asking

for a description of the characters of the diseases observed by them. In Alabama Phytophthora has not been observed, the prevailing disease there being due to other causes. In Connecticut Phytophthora was known to occur, but whether it caused the disease existing there was undecided. In Illinois Phytophthora also occurs, but the Macrosporium disease is very common and very destructive. In Kansas two writers stated that they had never found Phytophthora, but that Macrosporium was very common and abundant. In New Jersey Phytophthora is not common, but Macrosporium is. In Ohio Phytophthora is said to occur, but two botanists report not having found it. In Vermont *Phytophthora infestans*, *Macrosporium solani*, and a bacterial disease are all known to occur.

In addition to these data it may be added that out of many thousand specimens of diseased plants of various kinds submitted to the writer for examination during the past six years, not more than a dozen were affected by Phytophthora, while the Macrosporium disease was observed at least fifty times. Only two cases of Phytophthora have been observed in the field, both in Maryland, one in 1891 and one in 1893; on the other hand, the Macrosporium disease has been observed half a hundred times in as many different localities.

From this evidence it is believed the assertion may safely be made that *Phytophthora infestans* has been a comparatively rare fungus in the United States, at least during the last ten years. Furthermore, it is believed that much of the damage attributed to this fungus has been produced by the Macrosporium disease.

OBSERVATIONS ON THE GENERAL EFFECTS OF THE MACROSPORIUM DISEASE AND ITS PREVENTION.

During the summer and fall of 1892 some studies of the Macrosporium disease were made, and at the same time experiments were carried on with a view of preventing it. The following is a summary of the results:

The disease at first appears as small, nearly circular, grayish brown spots on the older leaves of the plants. On close examination the spots are seen to be made up of concentric rings of dark brown and gray tissue, and when young are to a certain extent limited by the veins of the leaf. The surface of the spots, especially on the upper side of the leaf, is roughened by more or less circular, narrow, dark brown elevations. As the disease progresses the spots become confluent, especially those along the edges of the leaves. In a week or ten days probably one-half the leaf surface will be affected, the rest assuming a sickly yellowish hue. Usually at the end of two or three weeks the entire leaf is brown and shriveled, but remains attached to the stem. The plant continues to grow feebly, but about a month after the disease appears the entire plant, except the main stem, is dead. This remains green a week or so longer, and then dries up from lack of food and water. As soon as the leaves are attacked the tubers stop growing, and although scarcely larger than walnuts they are mealy and keep well.

The Phytophthora disease, on the other hand, generally comes on suddenly. Green and vigorous plants are killed to the ground in two or three days, the tissues becoming soft, blackish, and foul-smelling. The tubers are also attacked, the fungus reaching them through the stem and reducing the tissues to a rotten mass.

The microscopic characters of the disease, together with the life history of the fungus, have been carefully studied, but it is unnecessary to enter into details upon these matters here. Suffice it to say that the fungus grows readily upon artificial media, producing an abundanceof

spores or reproductive bodies, which may, without difficulty, be made to infect healthy potato leaves. Spores of only one kind have been observed, and these live over winter on the dead potato leaves and can be made to infect the healthy ones as soon as they have attained the proper size.

In order to obtain some information in regard to preventing the Macrosporium disease, two series of experiments were conducted in the summer and fall of 1892 at Garrett Park, Md. One of these was to ascertain the comparative value of Bordeaux mixture (full and half strength), ammoniacal copper carbonate solution, and sulphosteatite;

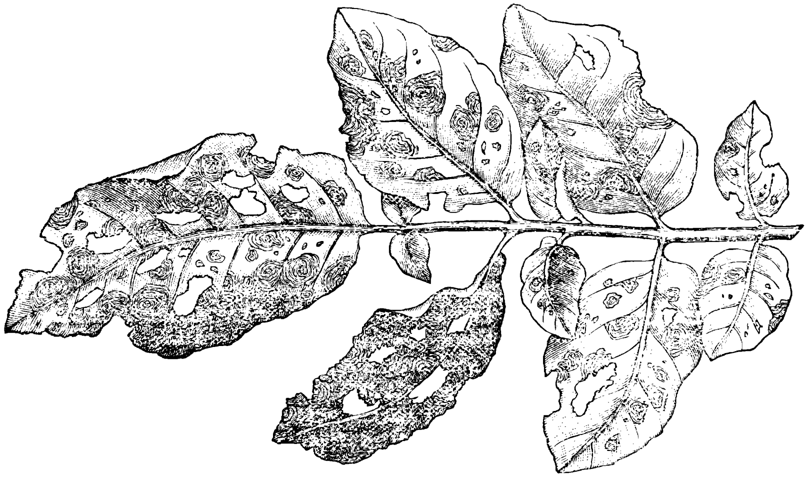


FIG. 1.—Leaf of potato affected with the Macrosporium disease.

the other was to try to prevent the attack of the disease after the plants were 10 or 12 inches high, but before the fungus had appeared. Without going into details it may be said that Bordeaux mixture, full strength, gave the best results. The following table gives the various treatments and yields:

Yield of plats treated for the Macrosporium disease.

Plat.	Method of treatment.	Yield of— Salable potatoes.	Yield of— Unsalable potatoes.	Total yield.	Yield per row of 400 feet— Salable potatoes.	Yield per row of 400 feet— Unsalable potatoes.	Total yield per row of 400 feet.	Weight of 100 largest potatoes.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1	Sprayed with Bordeaux mixture, full strength, 6 times	265	98	363	66	24	90	39
2	Untreated	47	49	96	23	24	47	22
3	Sprayed with ammoniacal solution of copper carbonate 6 times	58	95	153	14	24	38	22
4	Untreated	27	67	94	13	33	46	21
5	Sprayed with Bordeaux mixture, one-half strength, 5 times	162	79	241	40	19	59	35
6	Untreated	38	37	75	19	18	37	20
7	Dusted with sulphosteatite 6 times	109	62	171	27	15	42	26
8	Untreated	45	28	73	22	14	36	28
9	Sprayed with Bordeaux mixture, full strength, 6 times	289	80	369	58	16	74	41

From the above table it will be seen that the plats treated with Bordeaux mixture, full strength, produced by far the largest quantity of potatoes and comparatively the largest number of marketable tubers, and that the full-strength mixture produced better results in all respects than the half strength. The untreated plats yielded only half as well as those receiving the full-strength Bordeaux mixture. The yield of the plat treated with sulphosteatite was about the same as the untreated plat, and that treated with ammoniacal solution yielded even less than those receiving no treatment, the solution having killed the foliage, thus stopping the growth of the tubers before they were mature.

The general conclusion is that Bordeaux mixture, full strength, applied five or six times at intervals of ten days, is an effective remedy against the Macrosporium disease, almost entirely preventing the fungus and thus increasing the yield and improving the quality of the crop. Sulphosteatite had little or no effect in preventing the disease, and ammoniacal copper carbonate solution injured the plants, so that its further use can not be recommended.

In the second experiment Bordeaux mixture alone was used, the plats being treated four times. Soon after the first spraying the disease began to show quite plainly upon the untreated plats, and by the middle of September the plants were entirely dead, while the treated were still green. The yield of the treated plats was four times that of the untreated.

The results of both these experiments show that the Macrosporium disease can be successfully prevented by the use of Bordeaux mixture, full strength, applied from four to six times during the season. To obtain the best results, the first treatment should be made when the plants are 4 to 6 inches high. After this the sprayings should be repeated every ten or twelve days.

WORK ON FUNGICIDES.

Most of our knowledge on the subject of fungicides has been gained within the past eight or ten years. For many years certain powders and liquids have been known to possess fungicidal value, but it is only within the last decade that really serious efforts have been made to increase our knowledge on the subject. Up to about 1878 sulphur was the main reliance as a remedy and preventive of fungous attacks of all kinds. With the advent of the downy mildew of the grape in France, however, efforts looking toward the discovery of a remedy or preventive of this pest greatly stimulated investigators in this particular field. From 1878 to the present time there has been published a vast amount of literature bearing on the subject. This literature is widely scattered, the larger part of it being found in French, American, English, and Italian publications. With a view of bringing together the most important facts in regard to the matter a critical bibliographical index was begun by the division something over two years ago. Mr. Fairchild was placed in charge of this work, and during the past year, with the exception of about three months spent in Chicago in charge of our exhibit at the World's Columbian Exposition, his whole time has been given to the matter. The original plan of the work was to make a critical study of all the preparations known to have been used as fungicides, the investigations to include (1) a historical review of the discovery and use of the preparation, (2) a discussion of the various formulas and the manner of preparing the same, (3) the

chemistry and fungicidal action of each preparation, (4) the toxicology of the fungicide, (5) its effect on the normal living plant, and (6) its fungicidal effectiveness.

Mr. Fairchild was not able to complete the work as originally outlined, owing to the fact of his severing his connection with the division for the purpose of going abroad to study. It being seen early in the present year that the work as a whole could not be completed, at least by Mr. Fairchild, a special effort was put forth to finish the investigations upon the Bordeaux mixture, this being considered the most important of all known fungicides. Accordingly, the data upon all the other preparations investigated were put in convenient shape for future use, and all the remaining time was devoted to a study of the Bordeaux mixture. This part of the work is now complete and ready to submit for publication, forming, as pointed out elsewhere, Bulletin No. 6 of the division.

BORDEAUX MIXTURE.

In view of the interest in the subject it has been thought best to give here a résumé of the more important parts of the work. Beginning first, therefore, with a history of Bordeaux mixture, it may be said that it derives its name from Bordeaux, France, the place where it originated. As first used the mixture was a thick paste, composed of milk of lime and copper sulphate, and was employed to sprinkle on vines near highways in order to keep the former from being pillaged. Its conspicuousness, together with the prevalent idea that it was a virulent poison, rendered it very effective for the purpose named. It is not known when this practice originated, but it was first brought to the attention of viticulturists in 1885 by M. Millardet, professor of botany in the faculty of sciences of Bordeaux.

Some time during the season of 1882 Millardet visited the vine-growing region about Médoc and learned from the vineyardists there that such vines as they treated with this paste were entirely free from downy mildew. In 1883 he commenced a series of experiments to test the value of the mixture used at Médoc, and in 1884 repeated the experiments on a larger scale. Although the results of the work in 1884 were not decisive, owing to absence of the disease, still the author communicated such information as he obtained to the Society of Agriculture of Gironde May 1, 1885, and they at once set about testing the mixture. In 1885 Millardet repeated the experiments with marked success. To him, therefore, belongs the credit of bringing to the attention of the public a practical method by which copper sulphate could be used as a remedy for downy mildew.

The discovery, if such it can be called, like that of the fungicidal properties of sulphur, was made at a most opportune time, and shows the immense practical value of this branch of vegetable pathology. Much of the study on the mixture since 1885 has been directed towards determining the most economical strength, the best methods of preparation and application, and the extension of its use for the prevention of as large a number of plant diseases as possible. These questions have received more attention in America than in any other country, especially in the matter of testing this mixture as a preventive.

In France, strange to say, the use of the mixture is as yet almost wholly confined to the treatment of vine diseases. Many methods of preparing the mixture have been proposed, the formulas differing principally in the amount of copper sulphate and lime present.

The mixture, as originally used by the vine-growers of Médoc and afterwards described by Millardet, consisted of about 18 pounds of copper sulphate and 34 pounds of lime to 28 gallons of water. This was the formula first recommended and used in the United States. In 1888 experiments were made in this country under the direction of this division, then a section of the Division of Botany, and also in France by Millardet with formulas containing copper sulphate in amounts varying from 13·2 pounds to 2·2 pounds to 20 gallons of water.

The conclusions drawn from this work were that the weakest formula was fully as efficient in controlling downy mildew as the strongest. Accordingly, the same year the formula which has since come to be generally recognized as the standard, and which consists of 6 pounds of copper sulphate and 4 pounds of lime to 22 gallons of water, was recommended by the writer in Circular No. 6. This formula being firmly fixed in the minds of horticulturists, it has been suggested that, in referring to others, they should be reduced to the terms of the standard. Thus, should we diminish the strength one-half, we should refer to the mixture as the 44-gallon formula. The ratio of copper sulphate and lime, in other words, would remain constant, the only variable factor being the water.

Preparation of Bordeaux mixture.—In the preparation of the mixture some points recently brought out may be of interest. It has been found, for example, that much of the trouble in dissolving the copper may be avoided by tying the chemical in a piece of coarse gunny sack and suspending the package in the desired amount of water, 3 or 4 inches beneath the surface. Six pounds of granulated copper sulphate suspended in half a barrel of water will frequently dissolve in an hour, while if thrown directly into the barrel and allowed to sink to the bottom it may require a day or even longer to dissolve. Patrigeon's method of preparing the mixture has already been mentioned in the publications of the division. It may be referred to again, however, as it is worthy of extended trial. In this case the lime is not weighed, but is simply made into a milk, and what is supposed to be a sufficient amount added to the copper sulphate solution, the mixture being then tested with a half-saturated solution of potassium ferrocyanide or yellow prussiate of potash. If an insufficient amount of lime has been added, the mixture turns a chocolate brown upon dropping in the potassium ferrocyanide solution. If enough lime is present, no appreciable reaction takes place.

One other method of preparing the mixture may be mentioned here, i. e., making stock solutions of copper sulphate and lime. Fifty gallons of water will dissolve 200 pounds of copper sulphate; therefore in each gallon of the solution there will be 4 pounds of the chemical. One hundred and fifty pounds of lime and 50 gallons of water will make a milk containing 3 pounds of lime to the gallon. Therefore, to prepare from stock material 22 gallons of the standard Bordeaux mixture it will only be necessary to take 1½ gallons of the copper solution, pour it into a barrel containing 20 gallons of water, then add 5 quarts of the milk of lime. If there is not enough lime present, as shown by the potassium ferrocyanide test, add lime until no reaction takes place.

Chemistry and fungicidal action of Bordeaux mixture.—With regard to the chemistry and fungicidal action of this mixture, it may be said that these questions are as yet but imperfectly understood. At first the reactions supposed to take place when the lime milk was added to the copper sulphate solution were thought to be simple, but more recent investigations show them to be somewhat complicated. However, as

these matters will be fully discussed in the bulletin referred to and do not specially concern the fruit-grower, they may be omitted here.

The use of Bordeaux mixture from a hygienic standpoint.—Concerning the use of Bordeaux mixture from a hygienic standpoint, the investigations carried on fully sustain the statements already made as regards the harmlessness of the preparation when properly applied. The action of copper upon the human system is as yet imperfectly understood. That it can not be classed with such poisons as arsenic, lead, mercury, and phosphorus has been quite clearly shown by a number of investigators. Furthermore, it is known that in the daily consumption of food we absorb as much if not more copper than is found on a larger quantity of properly sprayed grapes than could possibly be eaten at one time by a single individual.

Another objection often raised to the use of Bordeaux mixture is its final effect on the soil after yearly additions of the copper salt. A number of experiments to throw light upon this point have been made by careful workers, and the only conclusion which seems warrantable is that the fungicide has not an injurious action upon the soil and is not at all likely to bring about its sterility.

The use of insecticides with Bordeaux mixture.—Recently it has been shown that the mixture can be used to great advantage in connection with the arsenites, particularly Paris green. The advantages of a combination of a fungicide and an insecticide are too evident to be dwelt upon here. It must be remembered, however, that caution is necessary in using such combinations immediately preceding the ripening of the fruit. The arsenites as usually applied are wholly blown or washed away before the treated fruit is ripe. When combined with Bordeaux mixture, however, this is not the case; consequently it is highly probable that the insoluble arsenites will remain on the fruit as long as the mixture itself. The question is one which needs investigating, and until settled by extensive experiments recommendations as regards the use of such combinations should be made with caution.

In conclusion, it may be said that the diseases successfully treated with Bordeaux mixture have already reached a considerable number. As a matter of record the following list may be given:

Apple scab (*Fusicladium dendriticum* (Wallr.) Fckl.).
Bean anthracnose (*Colletotrichum lindemuthianum* Sacc. & Magn.).
Beet downy mildew (*Peronospora schachtii* Fuckl.).
Cherry leaf-blight (*Cylindrosporium padi* Karsten).
Currant Septoria (*Septoria ribis* Desmz).
Grape black rot (*Lœstadia bidwellii* (Ellis) Sacc.).
Grape downy mildew (*Plasmopara viticola* (B. & C.) Berl. & de Toni).
Mignonette leaf-blight (*Cercospora resedæ* Fuckl.).
Pear leaf-blight (*Entomosporium maculatum* Lév.).
Pear scab (*Fusicladium pirinum* (Lib.) Fckl.).
Plum leaf-blight (*Cylindrosporium padi* Karsten).
Plum leaf rust (*Puccinia pruni* Pers.).
Potato blight or rot (*Phytophthora infestans* (Montaigne) de Bary).
Potato leaf-blight or Macrosporium disease (*Macrosporium solani* Rav.).
Quince leaf spot or blight (*Entomosporium maculatum* Lév.).
Raspberry anthracnose (*Glœosporium venetum* Speg.).
Strawberry leaf-blight (*Sphærella fragariæ* (Tul.) Sacc.).

WORK IN FLORIDA UPON THE DISEASES OF CITROUS FRUITS AND OTHER SUBTROPICAL PLANTS.

The work in Florida upon the diseases of citrous fruits and other subtropical plants has been pushed forward as rapidly as possible during the year. The laboratory, erected for the use of the Depart-

ment by the citizens of Eustis, was not completed until April, and for this reason systematic work did not begin until late in the year. The building is 46 by 36 feet, and contains a library, two laboratory rooms, a culture room, and a dark room for photographic work. It is supplied with gas and compressed air by means of a machine purchased as a part of the laboratory equipment. The compressed air is especially valuable for blowpipe and other work where great heat is needed.

The library is 20 by 16 feet, and contains about 180 linear feet of wall shelving and a case with 75 compartments for periodicals. In addition to the publications belonging to the division, the library contains the private collections of Mr. Swingle and Mr. Webber, the agents in charge, in all about 2,500 to 3,000 books and pamphlets, mainly special works bearing directly on the subjects under investigation. About 80 periodicals are regularly received and filed at the library.

Each of the laboratories has a wall table running the whole length of the room on the north side. These tables are furnished with cabinets of drawers and shelves, and are admirably adapted for microscopic work. The laboratories also contain tables for chemical work, with a sink at one end and a small shelf for chemical balances supported on piers free from all connection with the floor or wall. Microscopes, microtomes, and other apparatus necessary for use in minute investigations are, of course, provided. About 50 feet to the north of the building is a small tool house and shop, 10 by 14 feet, containing a bench and tools necessary in making simple pieces of apparatus. The pumps and nozzles for field work in testing remedies are stored in this building.

Besides erecting the building the citizens of Eustis have set aside for the use of the Department about $2\frac{1}{8}$ acres of land. Upon one-eighth acre of this the laboratory building is located, the rest being situated about three blocks distant. It is planned to conduct on these grounds miscellaneous experiments upon the diseases of citrous and other fruits, as well as to keep on hand an assortment of the most important varieties of subtropical fruits. For the more extensive field work owners of groves in various parts of the State have generously donated orange, lemon, and other trees of all ages. Furthermore, in many cases the owners continue to take all necessary care of the trees, besides furnishing the labor for the experimental work, thus materially aiding in the investigations without expense to the Department. With these various facilities at hand and the agents directly on the ground the work can be done in a thoroughly practical manner.

Passing now to the investigations carried on during the year in the field and laboratory, it may be said that five principal diseases have been studied, namely, orange blight, foot rot, die-back, lemon scab, and sooty mold of various citrous fruits. All but the last are of an exceptionally obscure nature.

ORANGE BLIGHT.

Blight is manifested first by a wilting of the leaves and second by a pushing out of water shoots from the trunk. The whole top finally loses its leaves and dies, and eventually the water sprouts, which at first appear healthy, also sicken and die. Very commonly there is a profuse late blooming the spring after the first appearance of the disease. No fruit of any consequence is produced after the tree is attacked. The annual loss from this source is estimated at $200,000.

Field experiments on this malady were begun in the summer of 1891, a few small, healthy trees being budded from blighted ones, in the hope of determining whether the disease could be communicated in this manner. So far no blight has appeared on the budded trees. Owing to the small size of the trees used it was not considered a satisfactory test, so the following summer (1892) a trial was made on 12 full-grown bearing trees in Mr. John Fabyan's grove at Leesburg, Fla., by budding a small upper branch with buds from a blighted tree. As yet the blight has not developed in any of these trees. However, the time which has elapsed since the trial was made is much too short to allow of any definite conclusions being drawn. The present year a somewhat similar experiment was started by budding the roots of 6 healthy bearing trees in Dr. Pendleton's grove at Eustis with pieces of bark from blighted trees. If the disease proves to be communicable, much light will be thrown on its nature, making it possible probably to cope with it, as in the case of peach yellows in Michigan.

Besides the foregoing experiments, others have been made to determine if grafting the vigorous shoots produced during the second stage of the disease with some early-bearing variety, for the purpose of securing remunerative crops of fruit before the tree dies, can be done with profit. The effect of certain fertilizers with and without spraying in preventing the disease is also being tested.

Another experiment in progress consists in copiously irrigating recently blighted trees every few days during dry weather. The fact that the first visible sign of the disease is a wilting of the foliage suggests the possibility of checking the further progress of the malady by insuring an abundant supply of water to the roots. Finally, an experiment having the same object in view consists in adding to the soil about the trees fertilizers calculated to increase the retentiveness of the soil for moisture.

Field observations of an extensive character made since 1891 seem to favor the view that the malady is contagious, and some evidence is at hand to show that prompt destruction of the first blighted trees will greatly diminish the likelihood of the spread of the disease. Careful tests having this matter in view will be made as soon as groves in proper condition can be found, the work to be done in badly diseased groves and in those where the malady is just starting.

The fact that the orange blight is of a very obscure nature, in many respects entirely different from any other known plant disease, necessitates much of the work being carried on in the laboratory. Investigations into the anatomy of diseased as compared with healthy tissues are well under way, and much carefully fixed and hardened material from a great number of cases has been accumulated for future study. The object of such studies is to find exactly what tissues are rendered abnormal by the disease and thus not only to render the diagnosis of doubtful cases more certain, but also to help greatly in showing what causes are probably at work. Laboratory researches having a similar aim have also been made on the physiology of diseased and healthy trees. Investigation of the loss of water from the wilting tissues has in particular thrown much light on the nature of the malady. Further studies on this subject, as well as on the carbon assimilation of diseased as compared with healthy leaves, are under way. Investigations are being conducted on the structure of the abnormal flowers so often produced the spring following the attack, as it is possible the disease is spread through the medium of the flowers. It is also expected that these studies will explain the unfruitfulness of diseased trees. Bacteriological methods are being used in examining tissues for the presence of

germs. These studies will be continued the coming year. Altogether it may be said that the results obtained so far from the work done in the field and in the laboratory have served to throw much light on the nature of the malady and promise results of great practical value in the future.

DIE-BACK.

This disease is distinguished by numerous symptoms, of which the following are the principal: The young twigs become stained by a reddish brown, resin-like exudation. The fruit early assumes an abnormal coloration, much of it soon falling, or in developing becomes large and coarse and frequently stained by a reddish exudation, like that occurring on the twigs. The growth made by the young twigs in the spring frequently dies back from the tip several inches, hence the name. This malady causes the loss of much fruit, renders much more of poor quality, and frequently permanently stunts or eventually kills the trees, especially if the land be low or poorly drained. The annual loss resulting from this disease may be conservatively estimated at about $100,000.

From various field observations it seems highly probable that the disease results from malnutrition, being probably induced in most cases by an excessive use of nitrogenous fertilizers. There is some evidence indicating also that the form of the fertilizer may have some effect in producing or aggravating the disease. Thus, in a region like Florida, where so general a use of commercial fertilizers is necessary, it becomes very important that a thorough knowledge of this disease be obtained.

A form of the disease known as "soil die-back," which is frequently by far the most destructive form, is not so obviously due to excess of nitrogen. It occurs on certain fields of limited area, which seem to produce the disease independently of the action of any fertilizer. Considerable loss is frequently incurred in planting out and nurturing groves on these so-called die-back soils. This might, perhaps, be easily avoided if the causes producing the disease were better understood.

In the study of die-back a series of field and laboratory experiments have been planned, having in view the definite determination of the causes and conditions producing the disease. Many of these have been inaugurated during the year, and others, it is hoped, may be started in a short time. In December, 1893, experiments were begun, using in different proportion the various kinds of fertilizer materials commonly employed to supply nitrogen. In each case only the form and quantity of the nitrogen content was varied, the phosphoric acid and potash being used in the form and quantity usually supposed to give the best results. In these experiments trees were selected of different ages and growing under different soil conditions. By continuing this experiment for several years light will probably be thrown on the cause or causes producing the malady. If, as supposed, the disease be due to excess of nitrogen, suggestions will also probably be obtained on the kind and quantity of nitrogenous manure which will produce the disease.

In November, 1893, a series of water-culture experiments was started in the laboratory, having the same object in view as the above field experiments. In these pure chemicals were used, only the amount and form of nitrogen being varied. In this and the following series of tests with sand cultures the form and quantity of food supplied are under complete control and thus constitute a necessary supplement to the field

experiments. Similar experiments with sand cultures, using 2-year-old trees, are also under way.

Observations on soil die-back have led to the opinion that this form of disease may be due to the collection of drainage nitrates. To test this theory experiments should be made with drainage gauges placed in various positions in die-back and healthy soils. Coupled with this a careful physical and chemical examination of the healthy and die-back soils should be made. Certain lines of work, which may be designated as remedial treatments, have been inaugurated. In brief, this work consists of experiments to test the effect of mulching the trees, severing the taproot, draining the soil, and the application to the soil of certain substances to retard nitrification.

FOOT ROT.

Foot rot of the orange and lemon is manifested by the appearance of gum on the bark near the surface of the soil, followed by the dying of a larger or smaller area of the bark, which is finally thrown off. In severe cases the roots are affected in a similar manner. Sometimes the tree is nearly girdled in the space of a few months. Whole groves have been destroyed by this disease within of a few years' time. The trees when first attacked sometimes bear unusually heavy crops of fruit, but afterwards cease bearing. The annual loss from this malady in Florida alone is estimated at $150,000. The same disease occurs in Europe and California. Budding on sour orange stock is an almost certain preventive, but from the fact that sour stock does not thrive very well on some soils, and since many of the oldest and most valuable groves in the State are on sweet roots, it is highly desirable that a cheap and efficient remedy be found for the disease. Already methods of treatment have been studied which promise to prove successful in these respects.

It seems probable that the principal cause operating to induce the malady is an imperfect aeration of the roots. Acting on this hypothesis it is proposed to carry on experiments in removing the earth from about the larger roots, thus exposing them to the air. In a grove selected for the purpose the work can be done by the use of a solid stream of water, under high pressure, from an irrigation plant. As there is considerable evidence to show that the fertilizers used have an influence on the appearance and spread of the malady, it is proposed to vary the amount and form used on the experimental plats in this grove. As it has been claimed that the gum from sick trees is able to induce the disease in previously healthy ones, when introduced into wounds made in the bark, trials to test this question are under way.

In the way of laboratory studies work has been done on the structure of the diseased tissues and at the same time searches made for parasites which may possibly cause or aggravate the malady. The most promising line of work, however, is on the effects of artificially controlling the supply of oxygen to the roots. For this purpose plants are being grown in pots, which renders it possible to study at the same time the effects of various fertilizers on the disease.

SCAB.

Scab of lemons, which also attacks limes, sour oranges, and Satsuma oranges, occurs in the form of warty excrescences on the fruit and leaves. It sometimes causes the young fruit to fall off, but more commonly simply disfigures it, rendering it unsalable. The annual loss in the State

from this disease is estimated at about $35,000. In some sections it is so serious that entire groves of lemon trees are cut off and rebudded to orange. It has been known to entirely destroy the lime crop in a grove. It is proposed to begin spraying experiments on this disease early in the spring of 1894 in the region of Lake Weir, Fla. The anatomical studies made of the diseased tissues show a corky formation, in many respects resembling potato scab. It is suspected that some similar micro-parasite may be the cause of it. There is already some evidence going to show that strong sprays, such as are used against various destructive insects, may lessen or prevent the disease, and it is proposed to test in this regard several of the best fungicides. Laboratory studies on the anatomy of the diseased tissues will be continued and further search will be made for possible parasites.

SOOTY MOLD.

This disease is due to the black fungus which follows the attacks of certain insects. In many places in Florida it is the cause of considerable loss, probably $25,000 annually. It spreads over leaves and fruit, interrupting the normal functions of the former and rendering the latter unsalable. Severe attacks may cause unfruitfulness of the trees. The nature of the malady is such that it doubtless can be cured by properly timed spraying. Trials are being made of several sprays and there is good cause for thinking that some effectual remedy will be discovered.

OTHER DISEASES OF CITROUS FRUITS.

Aside from these diseases of major importance, causing an annual loss of probably over $500,000, it may be said that there are also a number of others of less moment being studied as time can be found. Among these may be mentioned gumming of the trunk or limbs at a distance from the ground; rotting of the roots unaccompanied by gummosis; and a molding of Persian limes, which not only causes the loss of the fruits, but also more or less of the branches bearing them.

INVESTIGATIONS OF PLANT DISEASES ON THE PACIFIC COAST.

FRUIT TREE DISEASES.

During the year the agent located at Santa Ana, Cal., has studied a number of plant diseases. Among those of special interest may be mentioned a new disease affecting the buds and foliage of peach, cherry, and almond trees. As a result of the attacks of the malady, which is known to be caused by a parasitic fungus, the trees make very little growth, and in consequence the crop of fruit is materially decreased. In most localities the disease is gaining ground and bids fair to limit the profitable growth of both the peach and almond, and perhaps the cherry. Compared with the shot-hole fungus (*Cercospora circumscissa*), it is more rapid in its action, especially on the new growth. In many instances the tree fails to arrive at full leaf during the entire summer. It is yet too early to say what may be accomplished with fungicides in the way of preventing the disease. It is hoped, however, that an opportunity may be afforded during the ensuing year to test the preventive action of the copper sprays upon it.

A second new peach disease is now known to extend over most of California. It was studied at Chico in the spring of 1893, and has since been received from different localities bordering on the Sierra Nevada and San Bernardino mountains. It is a powdery mildew, prob-

ably a new species, and it attacks the fruit as well as the twigs and leaves. It is more abundant upon the fruit, appearing at about the same time as leaf-curl. Just how serious this disease is or may become in certain localities can not be said, but further studies of it will be made and preventive experiments instituted when opportunity is offered.

A third disease is annually killing a large number of trees on the coast. It is caused by a parasitic fungus attacking the roots and body of the tree at and below the surface of the ground. It is not confined to any one species, but kills the peach, cherry, apricot, and other deciduous fruit trees, as well as the almond and walnut. Considerable time has been given to a study of this disease. It has been found to exist in most of the valleys of California, and it is believed to extend over the entire coast region, wherever sufficient moisture exists for the growth of the fungus. In a peach orchard of 11·6 acres, of which a careful record was taken in the spring of 1893, it was found that over 31 per cent of the original trees had been killed by the parasite. Most of the trees were replaced three to five times and each time they were killed. Young peach trees die in from two to four years, the spread and destructive action of the fungus being more rapid than that of the root-rot fungus (*Dematophora necatrix*) in the orchards and vineyards of Southern Europe. As attention has been given to this disease only during the past season, few experiments looking toward its cure or prevention have been made. As the parasitic nature of the trouble is no longer in doubt, growers will gain much by raising annual crops upon the infected soil. This practice should be followed instead of resetting trees.

Root diseases of this nature are very difficult to combat, so that at present the above recommendation, coupled with the removal of the affected trees, and the draining, loosening, and drying of infected soil is about all that can be suggested. When the disease shows above ground, as it sometimes does, the trunks of the trees should be washed with Bordeaux mixture. This prevents the germination of such spores as may be formed and lodge on the bark. The Bordeaux mixture is also useful in checking the development of the fungus for an indefinite period. For this purpose the mixture may be washed into the ground at the base of the tree, so as to soak the bark of the trunk below ground and the tops of the main roots. This treatment, if thorough, will often prevent the fungus from girdling the tree, limiting its action to the lower roots and thereby saving the tree for a considerable time. This trunk and root treatment is especially valuable when applied to large and bearing trees. Walnut trees which have attained a large size are very easily treated in this manner, the process being simple and inexpensive. Roots which were half rotted away were thus treated, and a later examination showed that the parasite was killed on the parts treated, its upward progress in consequence being stopped. Bordeaux mixture for this purpose should be comparatively strong, and to prevent injury to the roots somewhat more than the usual amount of lime must be used.

Leaf curl of the peach.—This destructive disease, occurring not only in California, but in many other parts of the country as well, was successfully prevented during the year. In the peach orchard where the work was carried on, it was found that the treated trees averaged 160 pounds more fruit per tree than the untreated, although the latter were exactly the same size as the former, and the soil conditions in both cases were practically identical. On this basis the yield of the entire

orchard of 20 acres, if treated, would have been increased 345,600 pounds, or more than seventeen car loads. It is desirable before making any general recommendation in regard to the treatment of this disease to carry on experiments for another season. This will be done the coming year in California and elsewhere.

WALNUT DISEASE.

During the past spring certain nurserymen handling seedling walnut stock found the roots of their young trees more or less affected with knots or galls. The matter was called to the attention of the agent, as it was feared the disease might spread by means of the infected stock. An examination showed the galls to be the work of a nematode worm. It has been found that these worms are very numerous in some of the more sandy and moist situations of southern California, and that they attack many kinds of plants. So far as observed, the walnut, fig, and peach are most affected, and the harm is done mainly to nursery stock, large numbers of young trees being wholly unfitted for sale.

An effort was made to learn if a hardy root could be found upon which the soft-shell walnut might be grafted. It was ascertained that the hybrids between the English walnut (*Juglans regia*) and the California walnut (*Juglans californica*) were affected. It was then thought possible that the California species itself might be exempt. A quantity of nuts were therefore procured, sprouted, and grown in infected earth, but a later examination of their roots showed that they, too, had become infected. A study of the hard-shell walnut groves showed that these trees were but little subject to the trouble, and it is now thought that this tree may serve as a stock upon which to graft the soft-shell variety. In addition to being almost free from the work of nematodes, it is also largely exempt from the crown gall or black knot so injurious to the more tender soft shell. Grafting upon this stock may thus serve a double purpose if these diseases should become so serious as to make it advisable to resort to grafted trees.

Another disease of the soft-shell walnut has caused some alarm among growers in the southern coast counties. It is not known as yet whether the primary cause of the trouble is due to some derangement of the vital functions of the plant or to parasitic organisms. The progress and destructive action of the disease are certainly very apparent. A small black spot first appears on the side of the nut husk while the kernel is still in the milk. The death of tissue beneath this spot gradually extends, spreading inward, and soon reaching the shell. Unless the shell is already hard the decay penetrates through to the soft meat of the nut within, and the whole is soon disorganized and turns black. As high as 50 per cent of the soft-shell nuts have been destroyed on many trees observed, and appearances indicate an increase of the trouble.

A study of the diseased tissue shows the presence of a bacillus, the organism being constantly present. Pure cultures of the bacillus have been obtained for spring inoculations, the tissue of the nut husk being too firm in the later part of the season to test the action of the organism with any degree of certainty. Observations indicate that unfavorable root conditions for the trees may have an important bearing on the primary development of the trouble.

GRAPE DISEASES.

Coulure of grapes.—One of the leading lines of work of the year has been the study of coulure, or the premature fall of the bloom and fruit of the raisin grapes. During the winter a circular letter was sent to many growers in the San Joaquin Valley and elsewhere, asking for information as to the comparative hardiness of varieties, the bearing of soil and age on the disease, the losses sustained, the supposed cause of the dropping, etc. Much general information and many valuable facts were thus obtained as a groundwork for the season's experiments. The majority of replies were in harmony with observations made in the field in 1892, so far as the main cause of the trouble is concerned. It is evident that unfavorable temperature and other atmospheric conditions, acting on the highly bred and tender Muscat of Alexandria and Muscatel Gordo Blanco varieties during bloom, result in infertile or nonfecundated flowers. This lack of fertilization causes the flowers to fall or else to develop into small, seedless berries, resulting in the formation of imperfect bunches. Coulure caused a loss of over $600,000 to the San Joaquin Valley alone in the single season of 1892.

Three main lines of work have been pursued looking to the prevention of the trouble: (1) A study of the effects of grafting susceptible varieties upon more hardy roots; (2) the stimulation of vines by sprays and root treatment just prior to the period of bloom; (3) the crossing of the Muscat of Alexandria with a good variety of raisin grape not subject to coulure, so as to obtain resistance combined with desirable qualities of fruit.

The first line of work has shown that coulure may be largely prevented by grafting. The second series of experiments has given mostly negative results. From the crossing of stocks the best results are expected. A vine known in California as the Malaga, and usually grown as a raisin grape, has been selected to cross with the Muscat of Alexandria. It embodies hardiness of bloom, top, and root, and the qualities which appear desirable. A suitable location for conducting the work was found in the Lucerne Vineyard at Hanford, Cal. During the blooming season the crossing was successfully accomplished, the Malaga being used as the pollinating variety. As a result of this cross several hundred berries set and arrived at maturity. It is hoped that plants grown from the seed of these berries will possess most of the hardy qualities of flower, top, and root, so marked in the Malaga. This view is based on the results obtained by Prof. Millardet in the production of over 10,000 hybrid vines. His work has shown that the vine used as the father transmits its hardiness to the new variety. Every effort will be made to obtain as many seedling plants as possible from the berries, and a careful selection from these seedlings should give a vine inheriting the fruiting qualities of the Muscat and the hardiness of the Malaga. It is hoped to enlarge upon this work the coming spring, when an effort will be made to cross the Malaga with the Muscatel Gordo Blanco and possibly with the Huasco Muscat and others. This line of work has never been properly developed in respect to the raisin grapes, and great opportunities are offered to benefit the raisin industry. A bulletin on coulure of raisin grapes is now being prepared, embodying the results to date. It will include a translation of a paper by Prof. Millardet on the hybridization of the vine.

California vine disease.—The work on the California vine disease has been mainly histological and comparative. A study of the root system was made in the field both in midwinter and in midsummer.

Much careful excavation was done about the roots of old and young typically diseased vines. All portions of the roots were carefully examined, the results, so far as throwing light on the cause of the disease, being unsatisfactory. The laboratory work has failed to reveal any organism capable of producing the disease, although the fresh tissues have been thoroughly studied. In this connection the work done by Viala, which was referred to in my last report, has been looked into very carefully. While the appearances figured by Viala are clearly to be seen in the leaf, the evidence that they represent, as claimed by him, a vacuolated Plasmodium abnormal to the vine (a species of parasitic Plasmodiophora) is certainly negative thus far. The literature on Plasmodiophora has been consulted and many careful observations and studies of *Plasmodiophora brassicæ* (club root of cabbage) have been made. The ease and certainty with which the spore-crowded cells may be distinguished in plants attacked by this parasite is worthy of remark when compared with the total lack of any such spore forms in the vine. Furthermore, the tissues infected by the Plasmodiophora readily yield up their amœboid forms in cultures when taken at the right stage; on the other hand, the vine tissue wholly fails to set free any such organism even under apparently the most favorable conditions. Through the kindness of Prof. Millardet, leaves affected by Brunissure, the European vine disease, have recently been received and compared with the foliage affected by the California disease. The studies made so far indicate that the two are widely different in nature. In Brunissure the upper epidermal cells are filled with a gum-like deposit (removed by the treatment of sections, as recommended by Prof. Viala), and the effects of the trouble are at the beginning superficial, appearing on the upper surface first, and for a long time not extending to the under side of the leaf.

In the California disease the characteristic foliage markings affect both sides of the leaf alike, passing directly through from upper to under surface, while the upper epidermal cells are not filled with gum. Further than this the markings peculiar to Brunissure may be at the side of the veins or include them, or the veins may limit the spread of the markings. This is totally different from the California disease, where the death of the tissue does not extend to the veins and its spread is not limited to any portion of the leaf tissue. Finally it may be said that the published evidence that Brunissure and the California malady are caused by species of Plasmodiophora needs to be supported by the isolation of the organism claimed to be present. It is also necessary that the spore form be found and described. There seems no sufficient reason why such large and well-filled cells as those of the palisade tissue of the vine leaf should not allow the escape of the plasmodium in moist cultures, as with *Plasmodiophora brassicæ*, if such a parasite be really present. The past season has shown that the disease has lost much of its virulence, but it remains present in most of the vine-growing sections of Los Angeles, Riverside, San Barnardino, and Orange counties. Some of the younger vineyards showing no signs of disease in 1892 developed it to some extent in 1893.

THE PEACH YELLOWS INVESTIGATIONS.

During the early part of the year the agent in charge of this work was occupied largely in the preparation of Bulletin No. 4, on experiments with fertilizers for the prevention and cure of peach yellows. Field work upon various problems bearing on the cause of yellows has

been continued in Michigan, Pennsylvania, Maryland, and Delaware, special attention being given to the questions of root immunity and the possibility of the transmission of the disease through the pollen tube. The peach belt of southwestern Michigan was visited, with results confirmatory of former observations, viz, that while peach yellows occurs over almost the entire peach district along Lake Michigan, it is discouragingly prevalent only in those localities where the law requiring the prompt destruction of affected trees is disregarded. In such localities the disease is as prevalent as anywhere along the Atlantic coast, while in localities which enforce the law many fine orchards are to be seen, the majority of the trees are healthy, and the culture of the peach is profitable. There is no longer any doubt as to the wisdom of destroying all affected trees as soon as the first symptoms of yellows appear, and that this belief is gaining ground among practical men is shown by the fact that since this investigation was undertaken five States have passed laws requiring the prompt destruction of all trees showing symptoms of this disease. The States which now have such a law applicable to the whole or a part of their territory are Michigan, New York, Connecticut, Pennsylvania, Delaware, Maryland, Virginia, and California, and in Canada the Province of Ontario. Microscopic examinations of diseased and healthy tissues are now in progress, but not ready to be reported.

MISCELLANEOUS WORK OF THE DIVISION.

In addition to the more detailed investigations described in the preceding pages, the division has had under observation during the year a number of minor matters, mention of which may not be out of place here. Two diseases affecting melons have been studied, with interesting results. The first attacks muskmelons, and in certain sections of the country destroys the foliage of entire fields. Constantly associated with this disease is a fungus belonging to the genus Alternaria, and it has been proved that it is the cause of the trouble. The other disease, which attacks cucumbers, muskmelons, and squashes, begins in the form of a wilt, one or more of the branches and sometimes the entire plant succumbing as suddenly as though the stem had been severed from the root. The wilted condition may continue for a few days, the length of time depending somewhat on the weather; then the affected parts wither and dry up completely. Bacteria, which clog and break down the fibro-vascular bundles or water-conducting tissues of the plant, have been found constantly associated with the disease. Cutting off the water supply causes the plant to wilt, and the other effects noted naturally follow.

The disease was produced by artificially pricking the germs of the fungus into the blade of the leaf, and this, together with the fact that insect bites or punctures invariably precede the first symptoms of the trouble, is strong evidence that the carriers of the disease are insects. Some experiments looking toward the prevention of the two diseases described have been made, but as yet it is too early to speak definitely upon this matter.

During the year considerable attention has been given to the diseases of plants under glass. Diseases of lettuce, cucumber, tomato, and other plants have been studied and some interesting results obtained. In work of this kind little benefit results from the application of the ordinary methods of combating fungous diseases in the field. Many of the

diseases of plants under glass are due primarily to improper cultural methods, and in order to point out and correct these, it is manifestly necessary to know what are the proper methods to pursue in order to grow a plant to the highest state of perfection. Such knowledge is gained only by actual experience and the careful application of laws governing plant physiology.

Under the head of miscellaneous work may also be mentioned the part taken by the division in the World's Columbian Exposition. For the greater part of the year preceding the opening of the Exposition much of my own time, together with that of several assistants, was given to the preparation of the exhibit of the division. From about the middle of April until the 1st of October a member of the divisional force was kept constantly on the ground to point out the laboratory methods in use by the division and to explain other matters to visitors interested in the scientific and practical part of our work. On the whole it may be stated that the exhibit was the means of awakening much interest in the work of the division.

REPORT OF THE ASSISTANT POMOLOGIST

SIR: The position of Pomologist having been vacant during the greater part of the year, it devolves upon me to transmit herewith a condensed report of the work of the Division of Pomology during 1893.

Very respectfully,

WM. A. TAYLOR,
Assistant Pomologist.

HON. J. STERLING MORTON,
Secretary.

OFFICE WORK.

Since June 15 the position of Pomologist has been vacant. Of the special agents, one was dispensed with early in the year, but the other, Mr. T. T. Lyon, of Michigan, has been retained. A fruit modeler has been employed, so that additions to the collection of models exhibited at the World's Fair may be made as suitable specimen fruits are received.

The extra work required by the completion of exhibits for the World's Fair and the subsequent decrease in the working force of the division have necessarily limited field work and delayed the preparation of matter for publication. The manuscript for the bulletin on nut culture, however, has been revised and the original illustrations for it have been completed, so that it is now nearly ready for transmittal.

The correspondence of the division is extensive, covering a wide range of subjects, and its disposition requires much time. The preparation of conscientious and careful replies to all letters received often involves interruption in the constructive work of the division, yet the beneficial influences of such correspondence seem to be of sufficient importance to the fruit-growing public to justify the time devoted to it.

During the year papers or addresses have been presented by representatives of the division before horticultural societies in Maine, Connecticut, Delaware, and North Carolina, and before the American Association of Nurserymen, the American Pomological Society, and the Horticultural Congress held in Chicago. Numerous other requests for such services have been refused, to prevent undue encroachment upon the other work of the division, but the results of frequent intercourse between the officers of the division and those in whose interests it was established are such as to make it a matter of regret that more such meetings could not have been attended.

THE FRUIT CROP OF THE YEAR.

The season was marked by two striking features—the almost universal failure of the winter apple crop in sections which ordinarily furnish an abundant supply of that fruit, and the large crops of peaches and grapes in the regions where those fruits are chiefly grown.

CLIMATIC CONDITIONS.

The winter of 1892–'93 was noticeable for its long continued, severe, and steady cold, the temperature during the period from October to March, inclusive, being below normal over most of the region east of the Rocky Mountains. The precipitation during this period was also less than usual over most of the country. On the Pacific slope these conditions were partially reversed, the temperature being more nearly normal and the precipitation considerably above the average.

In most sections less damage was done to tender fruit trees and the grape than was at one time anticipated. Some injury to small fruits was experienced, particularly in the middle and upper Mississippi Valley regions, owing to the fact that during the unusually cold weather of January and February the plants and bushes were but slightly protected by snow.

Taken as a whole, the winter was a favorable one for the fruit-growing industry, and the promising condition of orchards in early spring afforded additional proof that a winter of steady cold weather, even though severe, is less injurious to the trees and plants of temperate climates than a season of higher mean temperature, in which mild periods are followed by sudden and marked cold waves.

APPLES AND PEARS.

The failure of the apple crop was probably not chargeable to the severe winter, but in many sections to the damage to foliage and general vigor of the trees by leaf-blight and scab during the previous season. In other sections it was due to the fact that the trees had been allowed to exhaust themselves by overbearing in 1891 and 1892. These causes, together with unfavorable weather at blossoming time, conspired to prevent an average crop of this fruit in most parts of the country. The most notable exception was the region including the States of New Jersey, Delaware, Pennsylvania, Maryland, and Virginia, where a fair crop of apples was grown. In the first two States, however, the yield of marketable winter fruit was greatly lesssened by severe wind and rain storms in August and October, which beat the fruit from the trees and greatly diminished its value. In consequence of the short crop in most sections, prices of good apples have been high. In many instances they have sold in the markets at higher prices than oranges, and for the first time in many years apple dealers of New York and Ohio have been compelled to look to Maryland and Virginia for their winter fruit.

Apple exports during the year have not exceeded 22 per cent of those during 1892, while the average value per barrel of exported fruit has been about 17 per cent higher than in 1892, the export valuation during the two years being reported by the Treasury Department at $2.55 and $2.99 per barrel, respectively. In California and Oregon the apple crop has been good, and numerous carload shipments to Eastern markets have been made. One carload of 1,000 forty-five pound boxes of

Bellflower from California is reported to have been sold in St. Louis in November for $1,800, or at the rate of 4½ cents per pound. This price leaves a handsome profit to the grower after deducting shipping and other expenses.

The yield of pears has been below the average except in the South, where the Kieffer and Le Conte varieties bore full crops.

PEACHES, PLUMS, AND SMALL FRUITS.

The crop of peaches was large in the sections which produce this fruit in commercial quantity, notably in Texas, Mississippi, Michigan, Connecticut, and on the Chesapeake peninsula. The fruit of late varieties was much damaged, and in some cases totally destroyed, by the violent storm of August 28–29. Prices of this fruit ruled low during most of the season.

The plum crop was less than an average one in most sections, though in the prune districts of the Pacific slope the crop was large, some estimates placing the yield of prunes as high as 50,000,000 pounds.

Small fruits yielded a short crop; the later ones, such as raspberries and blackberries, which survived the winter, having been cut off by drought in many sections.

GRAPES.

Grapes were everywhere abundant, and in the principal grape-producing belts they were of excellent quality, being less affected by black rot than for several seasons past. The recent extension of the period during which fresh grapes are obtainable in our markets is one of the surprising developments in modern commercial pomology. Fresh grapes of American production can now be had from June to March at prices varying from 3 cents to 30 cents per pound at retail. They are all grown out of doors, the lengthening of the season being due to the increased planting of table grapes in the South, the improved transportation facilities, and cheap cold-storage.

In Florida the Niagara is now grown to a considerable extent for shipment. It ripens during June and July and is followed by the better dessert varieties, such as Delaware, Brighton, and Concord, from the Piedmont region of South Carolina. Then in succession the markets are supplied with Moore Early, Brighton, Delaware, Concord, etc., from North Carolina and Virginia during July and August. By September 1 the early varieties from the Ohio lake region and the great market vineyards of New York reach the market, and grapes are abundant and cheap until December. The later varieties, such as Catawba and Isabella, from the last-named region, are kept in good condition in cold-storage establishments until March, being withdrawn in small quantities to suit the needs of the market as the season wanes. In view of the marked success attained by New York exhibitors of this fruit at the World's Fair, where clusters of several varieties of the crop of 1892 were shown in good eating condition in July, 1893, it may reasonably be expected that in the near future the grape will compete in our markets with the apple, as an "all the year round" dessert fruit.

When it is noted that this wide extension of the market season has been accomplished within the limits of a single botanical species (our earliest and latest market varieties belonging to *Vitis labrusca*), and during a period of less than eighty years since the first named variety of that species was introduced to cultivation, the radical nature of recent progress becomes more apparent.

The large yield of grapes has resulted in an over-supply at certain times in most markets, and as a rule prices have been low. Improved methods of distribution and reduced expense in marketing have left a margin of profit for careful growers, however, while the opportunity of securing grapes of good quality at low prices has been a blessing to thousands of our working people.

The raisin-grape crop of California has been a large one and prices have been rather low.

ORANGES AND LEMONS.

The orange crop in Florida promises to be the largest ever grown in that State, and prices up to the end of the year have ruled low. Much the same condition exists in California. In both States large areas planted in former years with this fruit are now coming into bearing. A leading problem with the growers is to find a market for their product at profitable prices. An attempt at direct shipment from Florida to England, as noted in the report of the Pomologist last year, was not entirely successful, and the experiment has not been repeated on so large a scale. Shipments of choice fruit, carefully packed and handled, were made during October and November from Florida, via railroad to New York, thence by fast steamer to Liverpool, with good success. The quantity marketed abroad in this way has exceeded the single cargo of last year, and prices have been fairly remunerative.

An extension of the ripening season of this fruit by the origination or discovery of varieties ripening earlier or later than those now grown is desirable. Several such have recently come to notice, and further advances in this line are needed.

The lemon, from the fact that it is more easily injured by cold than the orange, has not until recently received the attention it deserves in this country. It must be said, too, that the measure of success thus far attained by planters of this fruit in Florida has not been encouraging. Comparatively few prime lemons have yet been marketed from that State. Transportation charges favor the European rather than the Florida grower, as the freight charge from the Mediterranean ports to New York is one-third less than that from Florida points to the same city. Importations of lemons for the year show a decrease of about 3 per cent, the total value of the imported fruit being $4,680,353 in 1893, as compared with $4,831,334 in 1892.

The fact that lemons of the finest quality can be produced in southern California renders this one of the most promising fruits for planting in that region at the present time, as the California product can probably compete successfully with Mediterranean fruit in the markets of the West.

FIGS.

The fig, though long grown in a small way in the Southern States, has hitherto been an unimportant commercial crop in the United States, outside of California, but is now attracting considerable attention in the Gulf States as a market fruit. The crop this year was a large one in that section. Though the climatic conditions there do not favor the production of dried figs, it has been discovered that the fruit can be easily canned, and when thus prepared it meets with a ready sale. In southern Mississippi considerable and annually increasing quantities have been put up by the canneries for several years. Most of the older

fruiting trees are found in gardens and dooryards. As some single trees yield from $20 to $30 per season from the sale of fresh fruit to the canners, many new plantings have been recently made.

Certain difficulties in bringing the trees up to a bearing age have been experienced, owing to the susceptibility of the young trees to damage by frost and the necessity for pursuing a method of culture different from that practiced with other deciduous fruits. The Mississippi Agricultural Experiment Station is paying some attention to this subject at its branch station at Ocean Springs. Judging from the results obtained there, it is thought probable that a method of treatment modeled after that which the tree receives in dooryards will be found best adapted to it, and that it will soon be added to the list of profitable fruit crops for the Gulf region.

EXHIBIT OF THE DIVISION AT THE WORLD'S FAIR.

For the Department exhibit in the Government Building a collection of wax models of fruit, numbering nearly 1,000 specimens, was prepared. It included about 625 varieties, representing 40 native and introduced species and numerous hybrids. Special care was observed to make the models exact duplicates in size, form, and color of the originals they represented.

The exhibit was intended to afford a means for studying and comparing the outside characteristics of the varieties of our cultivated fruits, regardless of time or season. To cover the wide range of variation due to soil and climate which is found in almost every well-known variety, it was found necessary to prepare models illustrating as far as possible the changes that result from growing the leading varieties in regions that differ widely in soil and climatic conditions. Thus, in the case of one leading variety of the apple, twenty models were shown, each a duplicate of a specimen regarded as typical of the variety as it appears when grown in a particular locality.

As this collection is to be preserved for the use of the division, it is important that it be enlarged by the addition of other varieties and of other specimens illustrating further variations found in varieties already modeled. Such work has been continued in a small way during the year, and a number of additions have already been made to it.

Nut culture in this country has but recently attained commercial importance. It is, however, attracting much attention in some sections, and its judicious extension is worthy of encouragement. The exhibit at Chicago was specially designed to aid the intending nut-grower to select varieties for planting, by affording him an opportunity to compare their merits and defects by personal observation.

Other features of the division exhibit were a cultural exhibit of strawberries, a collection of colored illustrations of fruits, and an illustration of the methods followed in this office in recording and describing fruits received for examination.

The larger part of the exhibit is to be returned and displayed in the museum of the Department. An exchange has been arranged by which a set of models of Japanese fruits, exhibited at Chicago by the Japanese Commission, is to be added to it. Prof. T. V. Munson, of Denison, Tex., has donated to the division his entire exhibit, comprising herbarium specimens, sections of wood, photographs of fresh fruit and leaves, and specimen clusters of fruit, of all American species of the grape and numerous hybrids. This collection has been made with great care, and illustrates the conclusions in regard to the classification of American

grapes which Prof. Munson reached when investigating that subject recently as a special agent of this division. The collection will be accessible to all persons who wish to study and examine it.

UNCERTAINTY OF VARIETAL NAMES OF FRUITS.

The comparison of specimens of leading varieties of fruits received for modeling has yielded some results that seem to warrant a thorough investigation of the varieties of tree fruits that are of commercial importance.

In addition to the wide variations found in well-established varieties, which are evidently the effect of soil and climate upon the tree and fruit, a number of cases have been found in which there are in our nurseries and orchards clearly defined different strains of the leading grafted or budded varieties. Most of the cases thus far noticed have been found in the apple and peach. These differences extend through almost the entire range of varietal characters, including size, form, color, season of ripening, color and texture of flesh, flavor, and keeping quality. Though perhaps not sufficiently marked to warrant the division of existing sorts into two or more varieties each, with the multiplication of names that would result, they are certainly of enough economic importance to engage the attention of propagators of these fruits.

As examples of such variations a few specific cases may be noted. A Maine apple-grower sends specimens of a strain of Tompkins King, which, though grown in the same orchard, is much more oblong and conical than the typical form of that variety. The new type is also a better keeper. Both forms are known as Tompkins King, but as they are evidently different and one probably superior to the other an investigation should be made and a comparative test instituted that the better one may be selected for propagation. Another Maine grower furnished specimens of an apple upon which he has taken prizes at fruit shows, where he exhibited it as Baldwin. Though bearing a close general outside resemblance to that variety, it differs so widely in texture of flesh and flavor and is so inferior in quality that, when cut, it is readily distinguished from Baldwin. From California two distinct types of Rome Beauty have been received, which show constant variations in size, form, and color, though grown in adjoining orchards. In this case, each strain can be found to the extent of several thousand trees in a single locality, and in all the cases cited the different strains are found to have been quite largely propagated, so that the possibility that the variation may be due to a direct effect of stock upon scion is eliminated.

In the peach, the variation within varieties is even more apparent. Such old and widely recommended sorts as Crawford Early, Foster, Oldmixon, and Stump are each found to contain two or more strains differing in size, form, color, season of ripening, quality, and productiveness. From the desultory investigation which it has been possible to make thus far, it is evident that our leading fruit varieties are much less distinctly and accurately designated by their names than is generally supposed.

As intending planters depend largely upon the advice of those who have had experience, in making selections of varieties for planting, it is important that the same varietal names should stand for the same sorts in all parts of the country. Very few fruit-growers now propagate their own trees for orchard planting; most of them are conse-

quently dependent upon the honesty, carefulness, and competence of the nurserymen who supply them with young trees. A careful and thorough field investigation and comparison of types, with a view to selecting the best one of each of the leading varieties for propagation, would meet the hearty approval of all honest nurserymen and result in great future benefit to the fruit-growing public. Such a work would properly come within the province of this division. It should include a close investigation and comparison of trees in regard to vigor and habit of growth, hardiness, and productiveness, and of the fruit in regard to size, form, color, flavor, season of ripening, and keeping quality. After definite conclusions are reached, nurserymen and fruit-growers could be notified and arrangements easily made by which they could secure at their own expense scions of approved strains for propagation.

The question of how this divergence within varieties has come about is an interesting one. Its answer in many cases can be only a matter of conjecture. In the stone fruits, particularly the peach and the plum, it has probably often resulted from the selection of buds for propagation from seedling trees, which, while bearing a general resemblance to the parent varieties, were different in some one or more particulars, often undesirable ones. In other cases it may have come from bud variation, a phenomenon to which are probably due most of the existing differences found within the varieties of the apple, though in some classes of this fruit, notably the Russian importations, there are numerous reputed seedling varieties that so closely resemble one another that they can be distinguished with difficulty even by experts.

SEEDS, PLANTS, AND SCIONS RECEIVED AND DISTRIBUTED.

Few importations of foreign varieties for introduction have been made; some exchanges with foreign nurserymen and fruit-growers have been arranged which it is hoped will prove mutually profitable. In this way varieties of several fruits have been secured and distributed. Seeds or scions of others have been furnished to the division by originators, for distribution, so that in all about 70 fruit-producing varieties have been received. They have been placed with 128 experiment stations and private growers for testing.

For the information of the general public it is perhaps well to state that no general distribution of such varieties is made. In most cases but few plants or scions of a variety are received and these are placed where they can be carefully and fairly tested in a climate likely to be suitable for their growth. They are usually placed with the State experiment stations, if such exist in the region in question, or if not, then with private growers there who are known to have special facilities for testing them.

When originators desire to reserve the right to disseminate the varieties furnished, they are sent to the experiment stations under restrictions, so that the property right in the variety is retained by the originator. In this way a general and fair test of the variety is made possible previous to its introduction and sale, a plan which can hardly fail to protect fruit-planters against many of the evils resulting from the indiscriminate introduction of untried sorts.

APPLE.

Through the kindness of Mr. Sigmund Katona, of Kecskemet, Hungary, scions of 24 varieties of the apple were received. These varieties

Mr. Katona regards as some of the most valuable Hungarian sorts, and they have not previously been introduced to this country. They were distributed to 8 experiment stations and 7 individuals in 13 States and Territories for propagating and testing. Though many of the scions were quite dry when received, it is gratifying to note that but one variety failed to grow. Several others made but little growth, but it is hoped that in a year or two it will be possible by exchanges of scions to establish the full set of varieties with each experimenter, and thus to come promptly to correct conclusions regarding their value for different regions. Besides these Hungarian apples, scions of 18 American varieties were sent out for testing.

PLUM.

Of the plum, scions of 8 varieties were received from Hungary and were sent to 3 experiment stations and 6 individuals in 7 States. All but one of these varieties were reported as alive at the close of the year by some of the experimenters.

CHERRY.

Five varieties of the cherry were received from Hungary and distributed to 6 experiment stations and 5 individuals in 8 different States. All of these varieties are reported as living at one or another of the testing places.

FIG.

Much confusion and uncertainty exists in the nomenclature of varieties of the fig grown in this country. Most importations hitherto made have been through commercial channels, and the accuracy of the nomenclature of varieties thus received can not be depended upon. To enable fig-growers to correct this unfortunate condition of affairs arrangements have been made with the Royal Horticultural Society of England to secure scions of the collection of figs in the gardens of the society at Chiswick for grafting. This collection, which comprises about 65 varieties of the fig, has been made with great care and is believed to be the most accurately named collection in existence. It is hoped that by grafting these scions on bearing fig trees in California, they can be brought into full fruiting the second year after insertion, and that prompt and accurate determinations of the identity of varieties already grown in this country can thus be made and the relative values of new ones approximately determined.

AVOCADO.

Seeds of *Persea gratissima* were received from Mexico through the courtesy of Mr. F. Foëx, of Eddy, N. Mex., and distributed for testing in the Gulf States and California. They were selected from two types of this fruit, both of which are reported to have borne fair crops this year, though subjected to a temperature of about 22° F. during a severe storm at blooming time. They are believed to be superior in point of hardiness to the types of this interesting and useful species previously grown in the Southern States.

AUSTRALIAN FRUIT AND NUT TREES.

Through the kindness of Messrs. Pink & Cowan, of Brisbane, Australia, a few trees of a new variety of mandarin, "Beauty of Glen Retreat," were received. This is of Australian origin and, though

rather small, is claimed to be the finest variety of this fruit grown in that country.

Plants of several Australian economic and ornamental species were received and placed in the greenhouses in charge of the Superintendent of Gardens and Grounds. Among them were the following fruit and nut-producing species, mostly of a tropical or semi-tropical character:

BURDEKIN PLUM (*Spondias pleiogyna*).—A tree bearing a fruit described as a somewhat globular drupe, 1 to 1½ inches in diameter, of dark color and nice acid flavor. "Likely to prove useful under cultivation."

HERBERT RIVER CHERRY (*Antidesma Dallachyanum*).—A small tree, bearing fruit of the size of large cherries, having a sharp acid flavor resembling the red currant.

QUEENSLAND TAMARIND (*Diploglottis Cunninghami*).—A tall tree with large pinnate leaves; fruit from half an inch to 1 inch in diameter, of delightful acid flavor.

CANDLENUT (*Aleurites Mollucana*).—A tree of considerable size, bearing nuts rich in a palatable oil, used for various purposes in many of the islands of the Pacific.

QUEENSLAND NUT (*Macadamia ternifolia*).—A tree sometimes 50 feet high, bearing a nut about 1 inch in diameter and of very delicate flavor and fine quality. This was introduced into California several years ago. It does not endure frost.

MISCELLANEOUS.

Plants of one variety each of strawberry, gooseberry, grape, hazel, and black walnut have been distributed; also scions of 5 varieties of the kaki and 4 varieties of the native persimmon. Seeds of 2 choice types of the papaw (*Asimina triloba*) and a few walnuts were also sent out. Among the latter were nuts of the California walnut which were sent to the Gulf States to test the availability of this species as a stock for *Juglans regia* in that region.

PROMISING NEW FRUITS.

The examination of new fruits sent by growers for opinions as to their relative merits and probable usefulness has disclosed some new varieties that are worthy of propagation. Descriptions of such as seem most promising are given below, some of them being illustrated. Many of the varieties described have not yet been introduced to the public nor offered for sale by the originators. It should be understood that the Department does not propagate these varieties nor distribute them, except in rare instances where the originators donate the plants or trees for that purpose.

This explanation seems necessary because of the numerous applications received for varieties described or illustrated in previous reports.

APPLE.

Adirondack (L. Delmar Hay, West Chazy, N. Y.).—Roundish, conical; regular, of medium size, with smooth surface, becoming glossy when rubbed; color rich yellow, washed and striped with red; dots small, straw color, slightly elevated; cavity large, round, deep, flaring; stem of medium length and thickness, slightly knobbed; basin small, nearly round, very shallow, with convex sides, slightly and regularly ribbed and downy; calyx segments rather small, meeting; eye small, closed. Skin thin, tough; core large, broad, heart-shaped, moderately open, clasping; seeds numerous, oval, plump, grayish brown; flesh yellowish white, granular, rather dry, tender; flavor mild subacid; quality good. Season, October to January in Clinton County, New York. Tree a good grower; resembles Baldwin in its bearing habit; hardy at its place of origin. This variety is said to have originated from seed of Westfield Seek-No-Further) crossed with Hubbardston. It is a promising early winter apple for northern New York and New England.

Aroostook, synonym *Aroostook Sunset* (J. W. Dudley, Mapleton, Me.).—A sweet russet apple, originated at Castle Hill, Me., by S. S. Stiles. In appearance the fruit resembles Pomme Gris, but is a better keeper. Said to keep in fine condition, without special care, until July. Tree hardy and an annual bearer in Aroostook County.

Babbitt, synonym *Western Baldwin* (W. R. Laughlin, College Springs, Iowa).—Oblate conical, angular, large; surface smooth, greenish white, shaded, washed and striped with red; dots few, light; cavity large, regular, deep, with gradual slope and russet markings; stem short, slender at fruit, thick at base; basin of medium size, regular, abrupt, furrowed; calyx segments very short, converging, slightly reflexed; eye very small and closed. Skin thick, but tender; core large, wide, conical, open, clasping; seeds few, of medium size, plump and brown; flesh yellowish white, fine grained, juicy, brisk subacid; quality very good, particularly for cooking. Season, winter. Tree large, a strong grower with large leaves and tough wood. Originated from seed of Baldwin by C. W. Babbitt, of Woodford County, Ill., about 1845. Though not a new variety this has but recently come into prominence as a market fruit. The tree is hardy and productive in the Central States.

Bryant (Plate I—G. W. Bryant, Vienna, Va.).—Roundish oblate, often oblique, large; surface moderately smooth, greenish yellow, shaded and splashed with dull red and striped with darker red, often covered with gray; dots numerous, large, russet, with protruding centers; cavity large, regular, deep, abrupt, russeted; stem short, rather stout; basin regular, very large, deep, with gradual slope, folded; calyx segments wide, short, reflexed; eye large, open. Skin thick; core conical, small, closed, clasping; seeds few, of medium size, plump, brown; flesh yellow, coarse grained, juicy, very mild subacid; quality very good. Season, late winter in Virginia. A very promising variety for market and dessert.

The original tree, now 75 years old, stands on Mr. Bryant's farm, near Vienna, Va., and is yet bearing. This variety was described in the report of the Pomologist last year but is repeated here to accompany the colored plate.

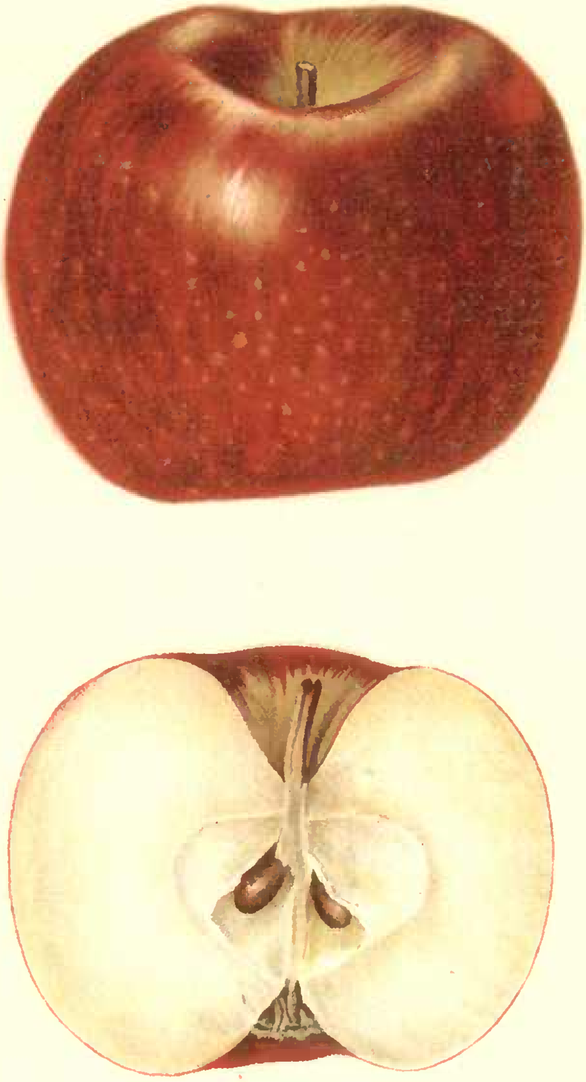
Cunningham (*Cheese*) (Thomas J. Garden, Gardenia, Va.).—Oblate, regular, of medium size; surface smooth, greenish yellow, almost covered with different shades of red, washed and striped; dots slightly russet, raised; cavity large, angular, deep, flaring, marked with yellowish brown russet; stem short, uniform, rather stout; basin large, nearly round, deep, broadly flaring, regular, nearly smooth; calyx segments converging; eye medium, closed. Skin thick, firm; core small, oblate, slightly open, meeting the eye; seeds numerous, rather large, broad; flesh yellowish, firm, juicy; flavor mild subacid, very pleasant; quality very good. Originated with Jacob Cunningham in Prince Edward County, Va., about 25 or 30 years ago.

Gardenia (Spring Hill Nursery Company, Gardenia, Va.).—Roundish, above medium size; surface moderately smooth, yellow, covered with dull red and obscurely striped with darker red, finely russeted; dots small to large, yellow and russet, often star-shaped. Skin thin, core of medium size, wide, conical, open, clasping the eye; seeds few, of medium size, short, plump, brown; flesh yellowish, rather fine-grained and juicy; very mild subacid; quality very good. Tree a vigorous grower, inclined to head low. A seedling on the farm of C. A. Price, of Prince Edward County, Va.

Hames (J. W. Kerr, Denton, Md.).—Roundish oblate, regular, large; surface smooth, whitish, almost entirely covered with mottlings, splashes and stripes of light and dark red; dots yellowish and brown, areolar and indented; cavity small, regular, shallow, with gradual slope; stem of medium length, stout, fleshy at both ends; basin of medium size, regular form, medium depth and gradual slope, corrugated, leather-cracked; calyx segments short, wide, erect or slightly reflexed; eye small, closed. Skin thick, tough; core of medium size, conical, closed, meeting the eye; seeds few, medium, brown; flesh yellowish, moderately fine grained; brisk subacid; quality good. This apple, which originated at West Point, Ga., was described by Downing in the Third Appendix to the Second Revision of Fruits and Fruit Trees of America, but seems not to have received the attention it deserves from apple-growers in the southern central States. The tree is described as a vigorous grower, upright, making a round head with age, and an early and good bearer annually. Its season of ripening in Caroline County, Md., is about three weeks later than Red Astrachan, or about August 15.

Kentucky Summer Queen (J. W. Kerr, Denton, Md.).—Roundish, truncated, large; very smooth, greenish white, nearly covered with splashes and stripes of dark red mixed with gray; dots conspicuous, yellow or light gray; cavity of medium size, regular form, moderate depth and gradual slope; stem short, moderately stout, with bracts; basin smooth, regular, of medium depth and gradual slope, downy; calyx segments short, wide, meeting; eye small, closed. Skin thin, tender, readily parting from the flesh; core large, wide, nearly closed, clasping the eye; seeds few, large, plump, light brown; flesh whitish yellow, fine grained, juicy; flavor mild subacid, rich; quality very good to best. Season middle of August in Caroline County, Md. A very promising market and dessert apple for late summer and early fall. The name is objectionable and needs revision.

Knight (David Johnson, Union, S. C.).—Oval, truncated, size below medium; surface smooth, glossy, greenish yellow, washed, striped, and almost entirely covered with two shades of red; dots numerous, large, conspicuous, slightly raised; cavity medium, round, quite deep, abrupt; stem of medium length and thickness, slightly



Forbes Co. Boston

BRYANT APPLE

D. G. Passmore

swollen towards the base; basin quite large, nearly round, rather deep, abrupt, slightly ribbed and with slight bloom; calyx segments tightly closed over the small eye; core small, roundish, closed; seeds few, quite large, pointed, dark brown. Skin thick, tough; flesh white, tinged with red; flavor very mild subacid, almost sweet; quality good. Tree of vigorous growth. Originated in Union County, S. C., and keeps through the winter in that section.

Marsh (G. W. Walker, Friendsville, Tenn.).—Nearly round, of medium size; surface smooth, a little angular, dull green, modified by dull red striping and clouding; dots gray, numerous near apex; cavity medium, somewhat irregular, of medium depth, rather abrupt slope, marked with slight knob on one side; stem ⅝ inch long, uniform, rather stout; basin quite large, round, shallow, with a broad, saucer-like slope. Skin of medium thickness, firm; core small, round, slightly open at the center, clasping; seeds numerous, broad, shaded brown and black; flesh greenish white, moderately tender, very juicy, mild subacid; quality good; season winter. Tree healthy, prolific; leaf large, leathery, light green above, gray beneath; broad obovate, with deep serrations. A seedling of North Carolina Buff planted 16 years ago by Mr. Marsh, of Blount County, Tenn. It fruited at five years from planting and has borne every year since.

Morven (Dr. J. J. Black, New Castle, Del.).—Oblate, pentangular, small; surface smooth, glossy, pale yellow, washed, splashed and striped with crimson; dots large, gray; cavity large, regular, deep; stem short, moderately thick, with bracts; basin medium in size and depth, regular; calyx segments wide, very short, converging; eye small, partially closed. Skin thin; core small, oblate, conical, closed, clasping the eye; calyx tube long; seeds short, large, dark brown; flesh white, fine grained, very juicy; flavor subacid, sprightly, pleasant; quality very good to best. A choice dessert winter fruit supposed to be a seedling of Lady.

Ross (William Stammer, South Osborn, Wis.).—Oblate conical, of medium size; surface smooth, yellow, with bright blush on sunny side; dots small; cavity regular, of medium size, deep, with regular slope and russet markings; stem very short, angular; basin regular, of medium size and depth, with gradual slope, folded; eye small, closed. Skin thin; core large, wide, conical, closed, meeting the eye; seeds large, plump, brown; flesh yellowish, fine-grained; brisk subacid; quality good. Tree a slow grower, forming a thick, compact head; young wood slender and willowy. A productive variety and a long keeper. Originated in Outagamie County, Wis., 25 years ago.

Scotch Red (J. Van Lindley, Pomona, N. C.).—Roundish oblong, of medium size; surface smooth, glossy; color nearly a solid red with a few russet patches; dots russet; cavity medium, regular, deep, abrupt, marked with light russet; stem short, slender; basin medium in size and depth, regular with gradual slope, marked with deep furrows; calyx segments long, narrow, meeting and slightly reflexed; eye small, closed. Skin thick, tender; core of medium size, closed, conical, clasping the eye; seeds few, large, plump; flesh white, rather coarse grained and crisp; flavor sweet and rich; quality good. Season August, in western North Carolina. A choice red, sweet apple for late summer and fall.

Strinestown, synonym *Streintown Pippin* (H. S. Rupp & Sons, Shiremanstown, Pa.).—Roundish conical, medium to large; very smooth and glossy, greenish white, blushed with light red on the cheek; dots numerous, light; cavity medium, rather narrow, deep with a gradual slope and russet nettings; stem medium, slender, curved, brownish red; basin large, irregular, deep, abrupt, folded; calyx segments quite long, converging and reflexed; eye small, nearly closed. Skin thin, tough; core small, closed, conical, clasping; seeds numerous, of medium size, short, plump, brown; flesh whitish, rather coarse grained, firm, juicy; subacid; quality good. Season February and March. This variety originated near the town in Pennsylvania for which it was named, and is one of the most regular and prolific bearers of marketable fruit in that section.

Tunnell (S. Tunnell, Cincinnati, Ark.).—Roundish oblate, above medium in size; surface moderately smooth, greenish yellow, striped, shaded, and splashed with red and somewhat netted with russet; dots numerous, large, yellow, with brown centers; cavity large, regular, deep, with gradual slope and green markings; stem long, slender; basin large, regular, deep, abrupt, russeted; calyx segments wide, short, meeting over the eye, which is large and partially open. Skin thick, tough; core small, conical, closed, clasping the eye; seeds numerous, of medium size, plump, pointed, dark brown; flesh yellowish, fine grained, not very juicy; flavor sweet, aromatic, rich; quality very good. Season autumn in Arkansas. A seedling in Mr. Tunnell's orchard, 7 or 8 years old. Tree is thrifty and has been bearing for three years. A delicious sweet apple.

Venus (William Stammer, South Osborn, Wis.).—Oblong conical, large, somewhat angular; smooth, of a rich yellow color with a slight blush on the sunny side; dots numerous, brown; cavity regular, of medium size, deep, abrupt, slightly marked with russet; basin regular, of medium size and depth and gradual slope, folded;

calyx segments long, pointed, reflexed; eye large, nearly closed. Skin thin; core large, open, conical, clasping; seeds numerous, small, plump, dark brown; flesh yellowish white, fine grained; flavor subacid, pleasant; quality good. A winter apple claimed to have originated in Outagamie County, Wis., 20 or 25 years ago.

Wallace Howard (G. H. Miller & Son, Rome, Ga.).—Oblong, large; surface moderately smooth, greenish yellow striped with pale red; dots russet, some of them indented; cavity medium, regular, deep, with gradual slope and russet markings; stem three-fourths of an inch long, of medium thickness; basin small, regular, of medium depth and gradual slope, marked with very slight folds; calyx segments short, meeting over the eye, which is small and closed. Skin thick, tough; core large, conical, closed, clasping; seeds few, of medium size, plump, round, brown; flesh yellowish white, fine grained, breaking; mild subacid; quality good; season October. Grown from seed by Robert Boatman, near Dillon, Walker county, Ga., and named in honor of Rev. Wallace Howard by the Atlanta Pomological Society.

Whitman (George Ruedy, Colfax, Wash.).—Oblong, angular, irregular, large; surface uneven and ribbed, though with a smooth skin; color a dark greenish yellow, washed, splashed and striped with bright red; dots numerous, conspicuous, light colored, some with small russet centers; cavity medium, roundish, angular and slightly lipped, shallow, flaring; stem three-fourths of an inch long, rather stout, swollen at both ends; basin large, roundish, of medium depth and convex slope, ribbed and angular; calyx segments broad, short, reflexed above the large open eye. Skin thick, hard; core of medium size, conical, slightly open, meeting the eye; seeds numerous, small, plump, pointed, grayish brown; flesh yellowish, firm, granular, rather dry; flavor mild subacid; quality good. Season late winter and spring. Originated near Pine City, Wash., with a Mr. Ralls in 1875. Has borne regularly since 1880.

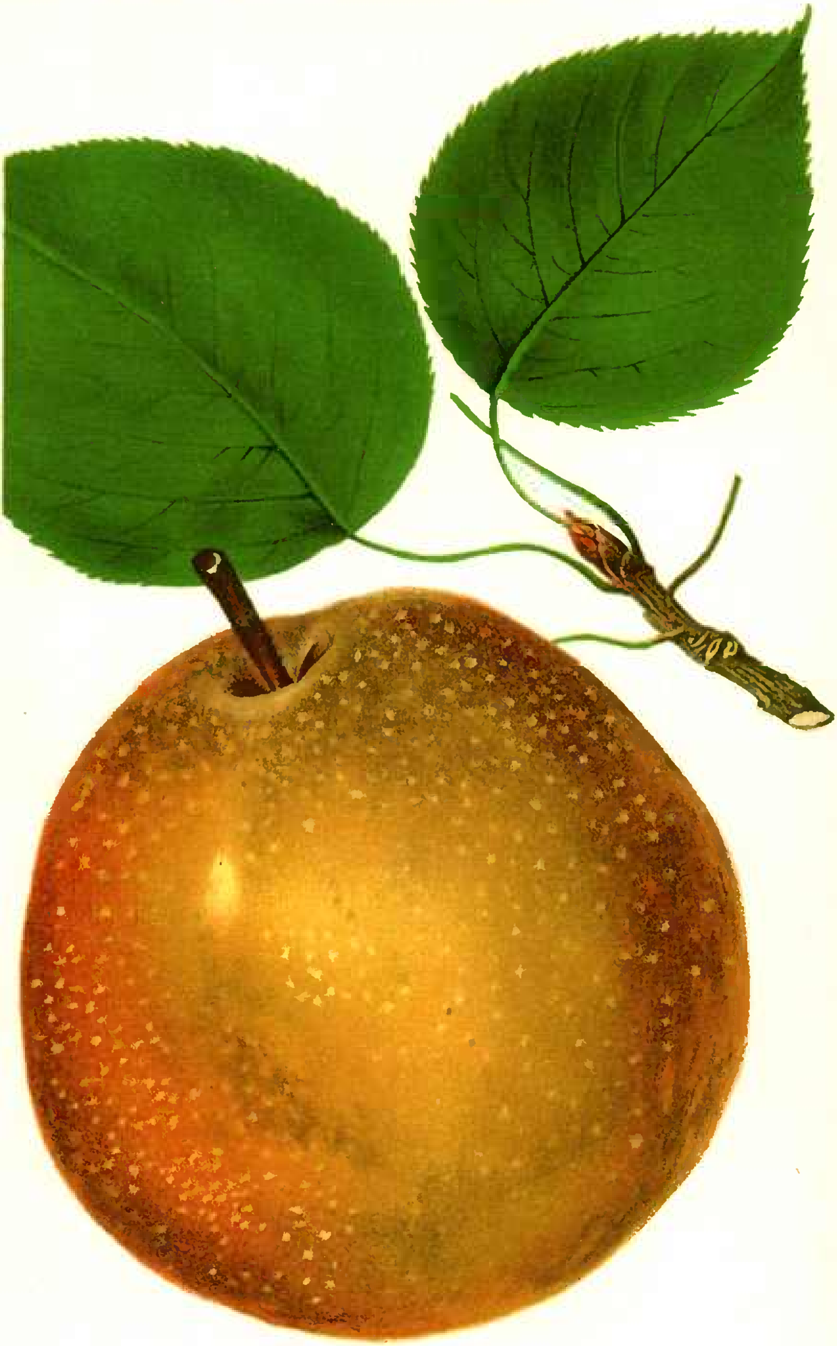
Willamette (J. N. Schram, Gresham, Oreg.).—Roundish oblate conical to oblong conical, irregular, ribbed; large, smooth, oily, resembling Lowell in this respect; color rich yellow, occasionally blushed; dots small, scattered, brown; cavity large, wide, deep, with gradual slope and green markings; stem short to medium, moderately stout, knobbed at base and very downy; basin irregular, of medium size and depth, abrupt and furrowed; segments wide, long, converging and reflexed; eye medium to large, nearly closed. Skin thin; core large, broad, slightly open, clasping; seeds few, of medium size, plump, brown; flesh yellowish white, fine grained, tender, juicy; flavor subacid; quality very good. Season early winter. A seedling from Multnomah County, Oreg. The original tree is 7 years old and has borne three crops.

Unnamed seedling (G. W. Walker, Friendsville, Tenn.).—Roundish oblate, of medium size; surface smooth, except fine leather-cracking; greenish white, washed and striped with two shades of red; dots yellow, some areolar; cavity medium in size, regular, of medium depth and abrupt slope, marked with slight russet; stem one-half inch long, of medium thickness; basin medium, regular, shallow, with gradual slope and slight russet nettings; calyx segments short, wide, reflexed; eye medium, open. Skin thick; core of medium size, wide, conical, slightly open, clasping the calyx tube; seeds few, plump, gray; flesh greenish yellow, fine grained, tender, juicy; spicy, rich, subacid; quality very good. Season winter. A seedling of Green Crank, probably crossed with Winesap.

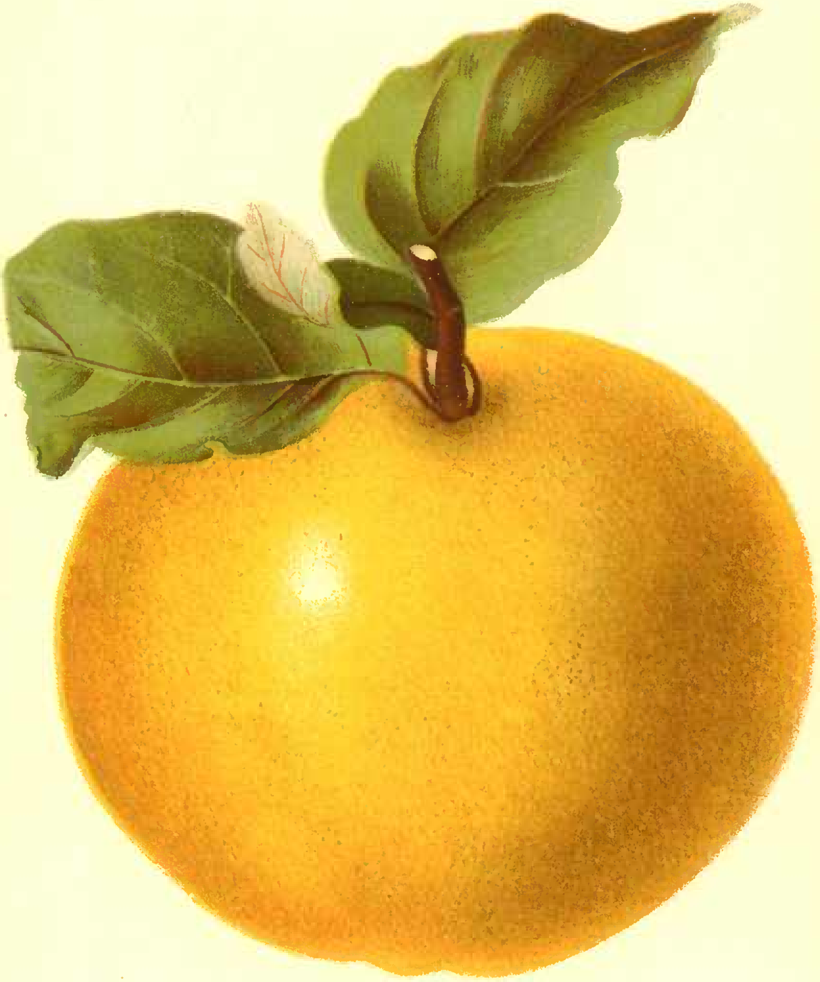
PEARS.

Crisco (J. Van Lindley, Pomona, N. C.).—Roundish, below medium size; surface moderately smooth; greenish yellow, nearly covered with russet; dots numerous, light russet; basin medium, irregular, of medium depth and abrupt slope, marked with netted russet; calyx segments short, stout, straight; eye small, closed; cavity very small, irregular, very shallow, marked with heavy russet; stem medium, stout, fleshy at base. Skin thin, tough; core medium, oval, closed, meeting the eye; seeds few, of medium size, plump; flesh greenish white, fine grained, juicy; flavor mild subacid, almost sweet; quality good to very good. Season September 1, in Guilford County, N. C. Reported to be a seedling grown by Robert Crisco in Richmond County, N. C. It is supposed to be a seedling of Seckel; has not blighted thus far in North Carolina.

Magnolia (Plate II—Jennings Nursery Company, Thomasville, Ga.).—Broad to roundish pyriform; large to very large; surface smooth, yellowish russet, tinged with red and brown in the sun and greenish on the shady side; dots numerous, irregular, large, light russet; cavity small, nearly round, shallow; stem medium, rather stout; basin large, round, rather deep, regular, funnel-shaped; calyx nearly or wholly deciduous; eye small, open. Skin thick, quite stiff but brittle; core conical, quite large, closed, meeting the eye; seeds numerous, broad, pointed, large, nearly black; flesh white, crisp, tender, juicy; flavor mild subacid; quality good, particularly for canning and preserving. Season late fall and early winter in



Forbes Co. Boston MAGNOLIA PEAR. D. G. Passmore.



JOHNSON QUINCE

Forbes Co. Boston D. G Passmore

southern Georgia. Tree said to be a healthy, thrifty, dwarfish grower. Original tree received in a lot of Japanese pear stocks from California in 1889. It is a promising variety for planting in the South where a later pear than Kieffer is desired.

Summer Beauty (Otto Locke, New Braunfels, Tex.).—Obscure, unequal pyriform, somewhat irregular, large; surface quite uneven, yellowish green with many russet spots and patches and a blushed cheek; dots numerous, russet; stem of medium length, rather stout, becoming fruity toward insertion; inserted with a lip, commonly without depression; basin roundish, irregular, medium to large, of medium depth and gradual slope, marked with slight angles; calyx segments thickened at base, the tips sometimes dropping off before the fruit is ripe; eye open or partially so. Skin rather thin, tough; core ovate, small, slightly open, meeting the eye; seeds imperfect; flesh greenish or yellowish white; sweet, rich, slightly astringent; quality good. Season August in Comal County, Tex. Succeeds as a dwarf. Original tree found in an old garden in New Braunfels in 1872. Trees grafted from it on quince stocks bore first in 1880, and have borne regularly since; heavy crops during past 5 years. Tree a late bloomer. Promising for western Texas where most varieties fail. Worth testing further north.

Tiffin (Philip H. Bork, Tiffin, Ohio).—Broad obovate, large; surface smooth, greenish yellow, with a few thin patches of russet, and a faint blush in the sun; dots numerous, brown; stem of medium length, slender, uniform, curved, inserted without depression; basin wide, of medium depth and gradual slope, russeted; calyx segments wide, reflexed, eye small, open. Skin thin; core large, oval, closed, meeting the eye; seeds large, plump, brown; flesh white, buttery; flavor mild, subacid; quality good. Season early October in Seneca County, Ohio, where it originated with Mr. Henry Loose, of Tiffin.

QUINCE.

Johnson (Plate III—W. B. K. Johnson, Allentown, Pa.).—Large, oblate conical, compressed at stem; surface moderately angular, glossy, somewhat downy in depressions; color greenish yellow; dots small, numerous, green; cavity slightly compressed, nearly level, broad; basin angular, large, abrupt, deep, with heavy angles; calyx segments leafy, becoming fruity at base; eye large; core oblate conical, large, open; seeds numerous; flesh yellowish, comparatively tender; juicy, mild, with a slight aroma; quality good; ripens ten days later than Orange. Has been grown by Mr. Johnson for about 15 years.

PEACH.

Balsey (John A. Young, Greensboro, N. C.).—Roundish oblong, with slightly uneven surface; creamy white, washed and striped with different shades of red; down short, persistent; cavity large, oval, deep, flaring; suture slightly depressed but distinctly marked, deeper towards the apex, which is minute and within the suture; skin moderately thick and strong; stone medium, semicling; flesh white to greenish white, melting, juicy; flavor mild, sweet; quality good. Season June 20 in Guilford County, N. C., ripening with the earliest varieties. Said to be a seedling of Connet, which it much resembles, but is twenty days earlier and of deeper color. Originated with W. G. Balsey, of Greensboro.

Crothers (T. T. Lyon, South Haven, Mich.).—Roundish, of medium size, smooth; greenish white, washed and shaded with crimson; down short, soft; cavity of medium size, regular, of medium depth, abrupt; suture very shallow except at apex, which is a minute dot. Skin thin, strong; flesh white, red at the stone, which is of medium size, oval, and free; texture melting, juicy; flavor sprightly, good. Season late; tree upright, spreading; flowers small; glands globose. T. V. Munson finds it to ripen with Ward Late in Texas and regards it as superior to that variety in that State.

Dixie (E. Balbach, Waldo, Fla.).—Roundish, above medium size; smooth, yellowish white, with a handsome blush; down short, persistent; cavity medium, regular, deep, abrupt; basal half of suture very deep; apex small, inclined. Skin thin, slightly bitter; flesh white, slightly tinged at stone, which is of medium size, oval, and a cling; texture firm but melting; flavor mild subacid, slightly bitter; quality good. Its good size and bright color may make it a good market variety in Florida.

Garden Cling (L. T. Sanders, Plain Dealing, La.).—Roundish compressed, of medium size; surface quite uneven; creamy white, with splashes of red on the shady, and dull red on the sunny sides; down harsh, persistent; cavity medium, oval, of medium depth, flaring; suture slightly sunken at base, even with the surface or slightly protruding toward the apex, which is very slightly sunken or protruding. Skin thick, tough; flesh yellowish white, firm, juicy, closely adhering to the medium-sized, smooth, plump, oval stone; flavor sweet, sprightly; quality good. Season July 25 in Bossier County, La.

Hance (*Golden*) (T. T. Lyon, South Haven, Mich.).—Roundish, of medium size; smooth, velvety, greenish yellow, shaded and washed with crimson and purple; cavity large, wide, deep, with gradual slope and pink markings; suture deep at base and apex and extending an inch beyond the latter, which is a minute dot. Skin thin, tenacious; flesh yellow, red at the stone, which is small, roundish oval, and free; texture melting, juicy; vinous, sprightly; good. Season with Crawford Early. Tree upright, spreading; flowers small.

Hyatt (T. T. Lyon, South Haven, Mich.).—Somewhat resembles Hale, but slightly earlier; more nearly a freestone and of better quality.

Indian Chief (L. T. Sanders, Plain Dealing, La.).—Roundish, pointed, large, with rather harsh surface; dark yellow, striped, splashed and shaded with purplish red; cavity large, oval, deep, abrupt; suture shallow; apex prominent. Skin thick tough; flesh yellow, streaked with red near skin and stone; stone large, oval, cling; texture firm; flavor very mild subacid, rich, good. Season in Bossier County, La., August 10. "A seedling of 'Hughes I. X. L.'" It is evidently of the Spanish type.

Keith (E. Balbach, Waldo, Fla.).—Roundish oval, of medium size; surface soft, velvety; greenish yellow, mottled and shaded with red; down short; cavity of medium size, regular, deep, abrupt; suture deep near base, shallow towards apex; apex slightly protruding. Skin thick, tender, slightly bitter; flesh white, slightly tinged with red at the stone, which is of medium size and a plump, oval cling; texture of flesh tender, melting; flavor mild, subacid, slightly bitter; quality good. Season early June at Waldo, Florida. A little later than Peen-to. A seedling of Peen-to. Originated by Robert Keith, of Waldo, Florida.

Murat (T. T. Lyon, South Haven, Mich.).—Roundish, bulged, of medium size; surface velvety, yellow, washed and mottled with red; down short, loose; cavity medium, regular, of medium depth and gradual slope; suture very shallow except at apex; apex a round point set in suture, about one-eighth of an inch below general surface. Skin of medium thickness, slightly bitter; stone above medium in size, oval, free; flesh yellow, slightly stained with red at stone; melting, juicy, vinous, sprightly; very good. Season late, ripening with Fox Seedling. Tree spreading; flowers small; glands reniform. Originated by C. Engle, Paw Paw, Mich.

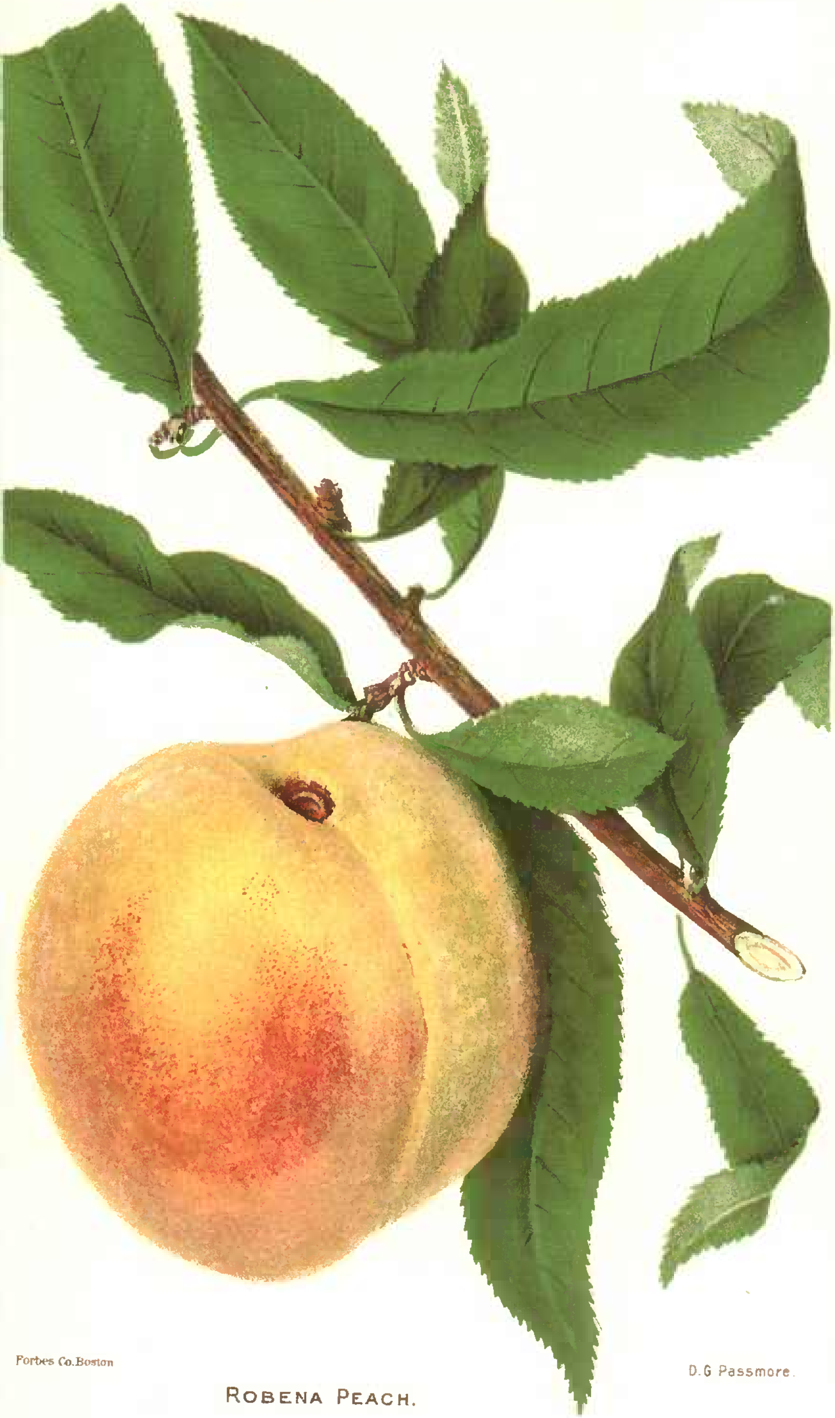
Orange Smock (J. W. Kerr, Denton, Md.).—Roundish oval, of medium size, slightly unequal; light yellow, resembling Beers Smock, splashed with some red in the sun; down long, abundant, persistent; cavity medium, oval, of medium depth, quite abrupt; suture of medium and uniform depth; apex small, with black tip within suture. Skin thick, harsh; stone quite large, broad, thick, free; flesh light yellow, red at stone, melting; not very juicy, tart, brisk, pleasant, good. Season September 5–10 in Caroline County, Md. Tree stocky and productive. Regarded by Mr. Kerr as superior to any other peach of the Smock type.

Pearl (T. T. Lyon, South Haven, Mich.).—Size medium, resembling in form compressed specimens of Oldmixon; surface velvety, creamy white, slightly shaded with crimson stripes; cavity large, regular, of medium depth and gradual slope; suture very shallow; apex a brown dot in shallow suture, and about even with general surface. Skin thin, slightly bitter; stone of medium size, oval, plump, free; flesh white, tinged with red at the stone; melting, juicy; mild subacid; good. Season about with Oldmixon. Tree spreading, productive; flowers small; glands reniform. Originated with C. Engle, Paw Paw, Mich.

Quality (J. W. Kerr, Denton, Md.).—Roundish, above medium size; velvety; white, washed and splashed with crimson; down of medium length, easily removed; cavity large, regular, deep, abrupt, marked with pink; suture very shallow, from cavity to apex; apex slightly protruding beyond the general surface. Skin thin, tough, with slight amygdaline taste; stone above medium, oval, compressed, free; flesh creamy white, tinged with red at stone; melting, juicy, vinous, sprightly, very good. Season last of August in Caroline County, Md. Tree productive. Mr. Kerr regards this, when eaten fresh from the tree, as superior to any other variety he grows.

Robena (Plate IV.—Dr. Thomas Taylor, Washington, D. C.).—Roundish, large; velvety, yellow, with shaded red and crimson cheek; down short, loose; cavity medium, regular, deep, abrupt, red; stem short, stout; suture long, from cavity to one inch past apex, shallow, except at cavity and apex; apex a double point within the suture. Skin thin, tenacious; stone of medium size, long, oval, compressed, free; flesh deep golden yellow, tinged with red at the stone; melting, juicy, mild subacid, vinous; quality best. Season late, October 1 to 10 in District of Columbia. Tree spreading, productive; shoots slender; glands reniform. This promising late dessert peach originated in the city of Washington. The original tree was produced about 6 years ago from seed of a seedling peach grown on Capitol Hill, and has borne good crops since it was 3 years old.

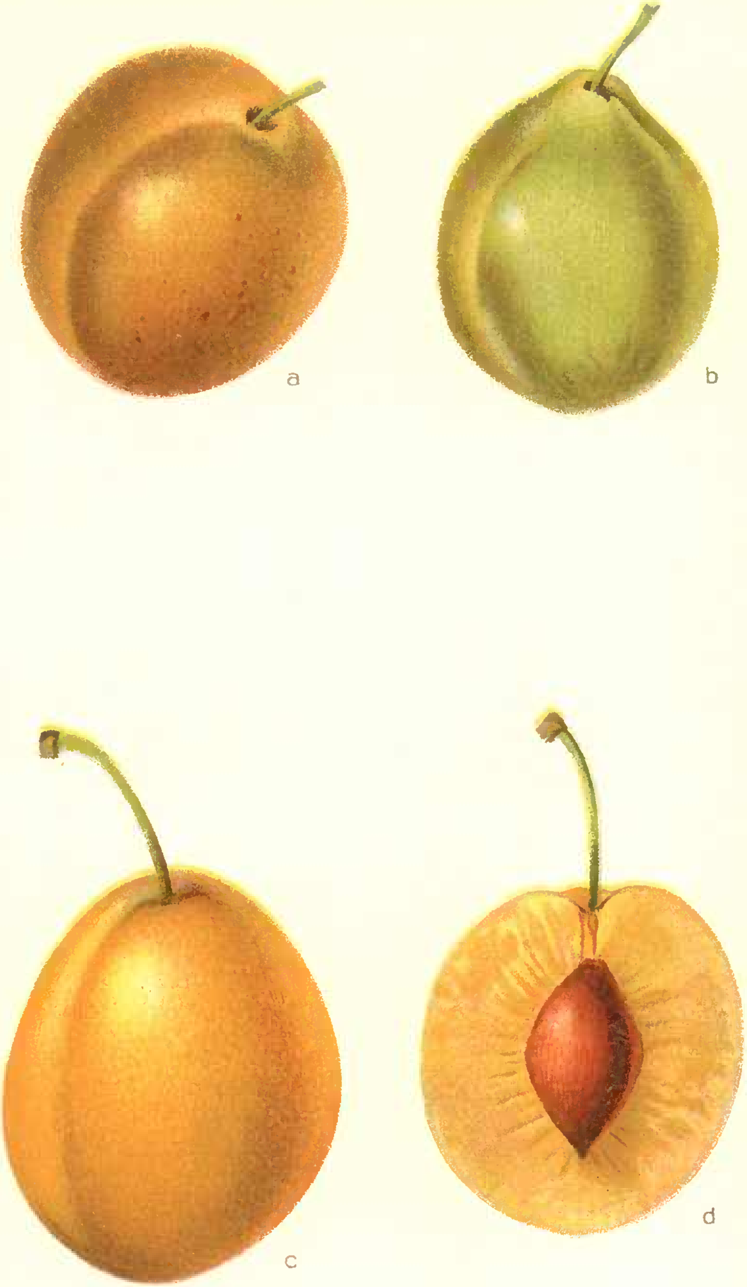
Rodgers (W. C. Rodgers, Nashville, Ark.).—Oblong, pointed, below medium in size; surface slightly uneven, a little harsh from its short persistent down; dull yellowish white, striped and blushed with red; cavity medium, roundish, oval, of medium depth and abrupt slope; suture uniformly distinct and moderately sunken from stem



Forbes Co. Boston

D. G Passmore.

ROBENA PEACH.



PLUMS

a - GOLDEN PRUNE b - COE GOLDEN DROP

c - YELLOW AUBERT d - YELLOW AUBERT, section

Forbes Co. Boston

to point of apex and continued as a depression on the opposite side of the fruit; apex pyramidal, protruding. Skin quite thick and harsh; stone of medium size, rather long, cling, very red; flesh dull yellowish white, with a little red at stone; firm, mild and sweet when well ripened; quality good. Season middle of November in Howard County, Ark.

Russell (J. M. Russell & Son, Wymore, Nebr.).—Round, above medium; velvety; whitish base, shaded and washed with crimson, becoming solid crimson on sunny side; down short, easily removed; cavity large, wide, oval, deep, abrupt, marked with green and pink; stem normal in length, stout; suture shallow except at apex; apex a small point near the end of suture. Skin thin, tender, bitter; stone medium to small, oval, plump, free; flesh greenish white with yellowish veins, red at stone, very melting, juicy; mild subacid, rich; very good. Season a month later than Alexander, in Gage County, Nebr. Grown from a seed of Hills Chili produced by side of Alexander; first crop 1893. In appearance this fruit resembles Hale, but the flesh is red at the stone and free.

Stiles (Dr. E. P. Stiles, Austin, Tex.).—A medium-sized fruit resembling Elberta, but claimed to be three weeks earlier; flesh reddish yellow, red at stone; melting, juicy, free; quality excellent. Perhaps more highly colored and sweeter than Elberta, but not so firm. Season June 25 to July 5 in Travis County, Tex. Originated from seed brought from Virginia and planted in 1866.

Tennessee (Rev. J. G. Teter, Athens, Tenn.).—Globular, above medium; surface almost harsh, with short persistent down; creamy white, with a suggestion of red on exposed side; cavity regular, medium, abrupt; suture from cavity to apex, shallow except at the ends; apex a double point even with or projecting beyond the general surface of the fruit. Skin thick, leathery, not bitter; stone above medium, oval, cling; flesh creamy white to the stone, firm, meaty, juicy, sweet, rich; very good. Season October 20–31 in McMinn County, Tenn. This peach is of the Heath Cling type, probably a few days later in season of ripening. At 3 years of age, in 1893, the tree bore 3 bushels of fruit.

Toquin (T. T. Lyon, South Haven, Mich.).—Roundish, of medium size; surface velvety, yellow, shaded with red near suture; cavity medium, regular, of medium depth and gradual slope, with yellow markings; suture shallow except at apex; apex a round point in a circular depression. Skin thin, stone of medium size, oval, plump, free; flesh yellow, melting, juicy; mild subacid; good. Season with Oldmixon. Tree upright, spreading; flowers large; glands reniform. Originated with H. E. Harrison, Toquin, Van Buren County, Mich.

Woerner (William T. Woerner, New Brunswick, N. J.).—Oblong, of medium size, velvety; creamy white, with a suggestion of red on cheek; cavity medium, regular, deep, abrupt; suture shallow, with delicate red line in center; apex a double point, slightly raised above general surface of fruit. Skin thin, strong; stone small, long oval, cling; flesh white to the stone, firm, sweet, rich; very good. Season October 20–31 in Middlesex County, N. J. Shoots stout, short-jointed, dark purplish red; leaf large with reniform glands.

Wright (*November*) (A. W. Eames, Los Angeles, Cal.).—Large, globular; surface velvety; rich orange yellow, shaded with red; down short; cavity large, regular, deep, abrupt; suture very deep and narrow at cavity, extending to the apex and marked by a red line; apex a wide double point protruding about three-sixteenths of an inch beyond the general surface. Skin thick; stone large, very plump, cling; flesh yellow, slightly tinged with red at the stone; firm, juicy, sweet, rich, very good. Season November 1–10 in Los Angeles County, Cal.; about a month later than Salway in same locality. Very productive.

Unnamed Chinese (Prof. C. S. Sargent, Jamaica Plain, Mass.).—Round to oblong conic, slightly unequal, compressed; size medium or below; surface smooth, almost free from down; color greenish white, sprinkled with irregular dots, which mingle into a faint blush on the sunny side; cavity medium, roundish, oval, of medium depth, with abrupt slope; suture rather deep, broad, and marked by a red line; apex a small protruding tip. Skin moderately thick, quite tough; flesh greenish white with green veins, and very slightly tinged with red at the stone, which is of medium size, rather long, slender, pointed, plump, free; flesh firm, juicy, somewhat fibrous; subacid to sweet, with hardly a trace of *noyau* flavor; quality good, better than many varieties now grown for market. Season September 5–15 at Arnold Arboretum. Tree a strong grower, vigorous, very productive and hardy. The blossom buds have not yet been killed by cold. Grown from seed received in 1868 at the Arnold Arboretum, from Dr. Bretschneider, who found it as a cultivated peach in the mountains north of Pekin, China. It is promising as a type for experimenters to use in the production of new, hardy varieties.

PLUMS.

Golden Prune (Plate V *a*.—Seth Lewelling, Milwaukee, Oreg.).—Oval, compressed, sometimes elongated, medium to large; surface even, somewhat roughened by rus-

set; color dull yellow with a light bloom; dots numerous, depressed; cavity round, small, shallow, abrupt; stem short, curved, and enlarged toward the base; suture shallow and rather broad from cavity to apex; apex depressed, often cracked in fully ripe specimens. Skin of medium thickness; flesh tender, amber yellow, melting, juicy; stone long, large, with a wing, free; quality very good, both for fresh use and for curing. Season early September, in Clackamas County, Oreg. Originated by Mr. Lewelling from seed of Italian Prune. A very promising variety for prune-producing regions. The illustration was made from medium-sized specimens grown at Napa, Cal.

Coe Golden Drop (Plate V *b*.—Leonard Coates, Napa, Cal.).—This well-known old variety is illustrated to furnish a standard of comparison for the newer varieties shown. It is one of the most widely grown late yellow plums and succeeds in almost all plum districts except the most northern ones, where it sometimes fails to mature its fruit. It is valued for its productiveness and excellent quality. It originated in England about the beginning of the present century. The illustration was made from a medium sized specimen grown at Napa, Cal.

Pacific (Sluman & Nunn, Mount Tabor, Oreg.).—Oblong, very large; smooth, glossy, dark brownish crimson; dots very numerous, golden; bloom profuse, light blue; cavity medium, regular, shallow, with gradual slope; stem short, rather stout; suture shallow, distinct; apex depressed and slightly leather-cracked. Skin thick, tough; flesh translucent, with white veins, melting, juicy; stone medium, oval, shouldered, nearly free; flavor sweet, rich, very good. Season latter half of September in Multnomah County, Oreg. Tree said to be a very upright grower and a heavy cropper since three years old. Originated at Mount Tabor. Promising for use in the fresh state as well as for curing into prunes.

Yellow Aubert, synonym *Dame Aubert jaune* (Plate V *c* and *d*—T. T. Lyon, South Haven, Mich.).—Oval to oblong, regular, large; smooth, glossy, greenish yellow, becoming a rich golden yellow, with translucent markings; dots numerous, small, green; bloom profuse, white; cavity medium, regular, deep, abrupt; stem rather long, of medium thickness, curved, downy; suture marked but not deep; apex a russet dot within the suture. Skin thick, tender, quite acid; flesh yellow, clear, translucent, melting; stone large, long, oval, pointed, cling; flavor mild, rich, almost sweet; quality very good. Season September 10–15 at South Haven, Mich. Somewhat resembles Yellow Egg, but is earlier and of better quality. Shoots stout, red on the sunny side; leaf oval, pointed, large, thick, dark green. This variety and several others, including Voronesh Yellow and Moldavka, were imported from Russia by the Iowa Agricultural College several years ago. They have fruited in Iowa for several years, and are valuable additions to our list of hardy plums of the *domestica* type. Prof. J. L. Budd regards Moldavka as the best variety of this class.

CHERRY.

Duraccia (E. E. Goodrich, Santa Clara, Cal.).—A heart-shaped bigarreau, of above medium size; smooth, glossy, finely pitted; very dark purple, almost black; cavity large, regular, deep, smooth; stem medium, three-fourths to one and one-half inches long, very slender; suture deep and depression extended beyond the apex. Skin thin, tough; stone medium, plump, semicling; flesh red with lighter veinings; very firm and meaty; rich, sweet, delicate; very good to best. Season July 15 to 25 at Santa Clara. Promising as a shipping fruit. This variety was received from Italy and grafted at Santa Clara. It may be the "Pistojese" of Italy.

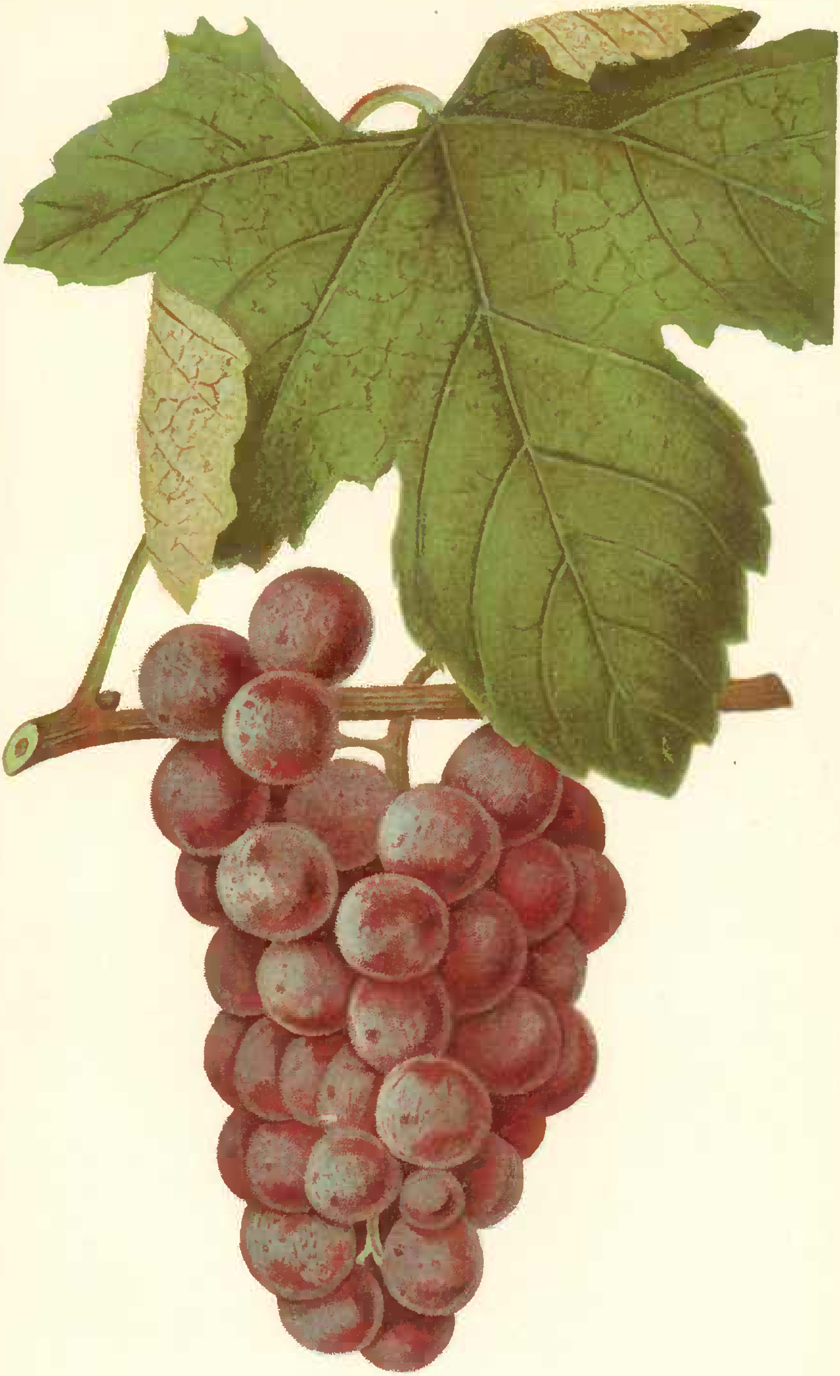
Hoskins (Plate VI—C. E. Hoskins, Newberg, Oreg.).—Roundish, heart-shaped, compressed; very large; smooth, glossy, dull purplish red, faintly mottled; dots indistinct, elongated; cavity round, of medium size and depth, with convex slope; suture not depressed; a mere line on the surface; apex slightly depressed. Skin thick, rather tough, leathery; stone plump, free, medium to large; flesh shaded with light and dark red; very firm, sprightly, sweet; good. Season early July in Oregon. Promising for market and long shipment. Tree reported as of vigorous, upright growth, very productive; young shoots brownish green with a gray over color and prominent yellow dots; leaves large, light green, ovate, coarsely dentate, with two large reniform glands. A seedling of Napoleon, originating with Mr. Hoskins 15 years ago.

GRAPE.

Azure (*Vitis æstivalis*) (J. S. Breece, Fayetteville, N. C.).—Cluster of medium size, cylindrical, with small shoulders, moderately compact and full; berry roundish, of medium size or smaller, adhering firmly; color black with heavy bloom; skin thick, slightly pulpy, with but little pigment; seeds three to four, quite large; flesh green, meaty, quite firm, moderately juicy; sweet with mild and very pleasant aroma; good for market or dessert. Season with Catawba.

HOSKINS CHERRY

Forbes Co. Boston D. G. Passmore



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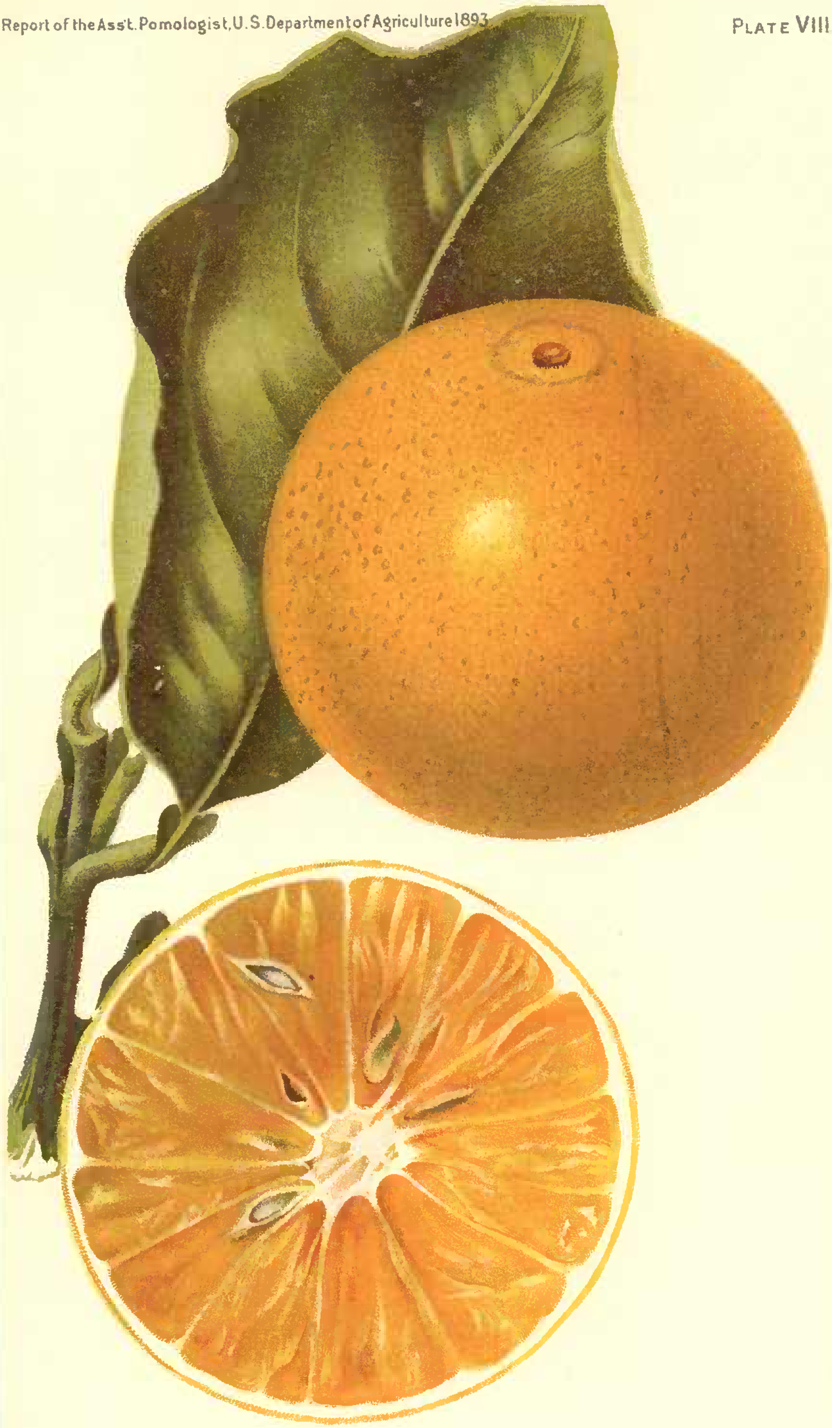
CRITIC GRAPE

Wm H Prestele



BOONE ORANGE

Forbes Co. Boston D. G. Passmore

Cozy (*Vitis labrusca*) (J. S. Breece, Fayetteville, N. C.).—Cluster of medium size, simple, very compact; berry slightly elongated, of medium size, adhering very firmly; surface smooth, black, with light blue bloom; skin thin, leathery, free from pulp, but with deep red pigment; seeds few, large; flesh translucent, tender, firm, rather dry; mildly sweet with mild labrusca aroma; good for dessert and for market. Season apparently a week earlier than Ives. Its value for general planting is lessened by the fact that its blossoms are pistillate, but its earliness renders it worthy of testing.

Critic (Plate VII—J. S. Breece, Fayetteville, N. C.).—Cluster medium, slightly shouldered, compact; berries round, of medium size, commonly larger than Delaware but quite variable; color light, dull red with quite heavy bloom; skin of medium thickness, rather tender, not objectionable in flavor; pulp translucent, tender, with abundant rich juice; seeds few, of medium size, light brown; flavor mild, sweet, less sprightly than Delaware, slightly foxy; quality good. Season earlier than Brighton. Vine reported to be vigorous and less affected by mildew than most varieties. A seedling of Jefferson, promising for market and dessert, as a substitute for Delaware where that variety does not succeed. Mentioned in report of last year.

Palmetto (*Vitis bourquiniana*) (David Johnson, Union, S. C.).—Resembles Herbemont very closely in form and size of cluster, also in size of berry, but is claimed to be distinct. In color this is a a dark garnet with heavy, light blue bloom; flesh soft, juicy, sweet, aromatic, vinous. Season middle of September in Union County, S. C.; two weeks later than Herbemont.

Waddel (*Vitis æstivalis*) (Dr. Edwin Waddel, Greenfield, Ohio).—Cluster of medium size, rather heavily shouldered, moderately compact, moderately full; berry oval, medium to large, adhering firmly; surface smooth, dark purple or black, with profuse blue bloom; glossy beneath the bloom; skin thick, tender, with considerable pulpiness and purple pigment; seeds few, large; flesh translucent, tender, melting, very juicy; mildly sweet, rich, pleasant, with abundant bouquet and slight musky aroma; good to very good for dessert, market and wine. Season September 20–30 in Highland County, Ohio. Vine productive and hardy; found in the woods of Highland County, Ohio, about 30 years ago, by John F. Waddel and transplanted to his farm.

Seedling formerly known as *McKinley's Jumbo* (*Vitis labrusca*) (J. S. McKinley, Orient, Ohio).—Cluster medium to large, shouldered, moderately full, not compact; berry very large, nearly an inch in diameter, roundish, slightly elongated, adhering firmly to the stem; surface almost black with a dull, heavy, brown bloom; skin rather thin and noticeably tender, with slight reddish purple pigment; seeds 3 to 5, large, grayish brown; flesh yellowish green, meaty, quite firm, moderately juicy, quite sweet, with foxy aroma. Season middle of October in Pickaway County, Ohio. A very large grape of fair quality. Vine a strong grower with large leaves.

RASPBERRY.

Ferndale (*Rubus occidentalis*) (W. B. K. Johnson, Allentown, Pa.).—Round oblate, large to very large, quite regular and smooth; crimson black with very heavy bloom; drupes large, flattened, showing suture; seeds of medium size and hardness; berry rather coarse but firm, moderately juicy; sweet, aromatic; very good; shipping quality good. Season slightly earlier than Gregg. Fruit borne in rather long spicate clusters; berries rather loosely attached to the receptacles. Canes reported to be very vigorous, with large, though not numerous, prickles. More productive than Gregg and a better berry, but perhaps less hardy. Promising for Central and Eastern States. From three-quarters of an acre of this variety Mr. Johnson harvested in 1892, 4,368 quarts. In 1893 the crop was about 1,000 quarts less, from the same area.

SEMITROPICAL FRUITS.

KAKI.

Godbey (T. K. Godbey, Waldo, Fla.)—Very large, some single specimens weighing more than a pound; conical, bright red, almost seedless; quality very good. Season early October in Alachua County, Fla. A seedling of Hyakume, originated by Mr. Godbey, who says of it: "Tree a rank grower, of spreading habit; very prolific."

ORANGE.

Boone (Plate VIII—C. A. Boone, Orlando, Fla.).—Roundish to roundish oblate, medium to large, with very smooth skin; oil cells small, depressed; color rather light orange. Peel medium to thin, tough; tissue thin, tough; seeds few, angular, of medium size; flesh rich orange yellow, sometimes tinged with red, tender; very juicy,

sprightly, sweet, with a trace of bitterness in the rag. Very early and of good quality; promising as a market variety. Tree a strong, vigorous grower with large leaves and winged petioles. Original tree grown from seed procured in oranges bought from a foreign vessel in Tampa, about 36 years ago. Mentioned in report of Pomologist for 1892.

WILD FRUITS.

PERSIMMON.

This native fruit, *Diospyros Virginiana*, is so widely distributed over the southern portions of the United States that its very abundance has no doubt fostered that contempt which familiarity breeds. But notwithstanding the low esteem in which it has been held, there are indications that it will soon become a staple fruit and worthy of the attention of the market-grower. A wide variation in the season of ripening, size, and quality of the fruit, and in the vigor and productiveness of the trees has been observed, which makes it a promising species for experimental work. Several enterprising fruit-growers have selected choice wild varieties for propagation and a few have already marketed fruit in considerable quantities. Among the best varieties thus far named and introduced are the Kemper from Tennessee, Early Golden from Illinois (mentioned in report of the Pomologist for 1891 under the incorrect name Alton), and the Marion and Golden Gem described below.

On Plate IX, *a* and *b*, illustrations of the two last-named varieties will be found, and also of a seedless wild persimmon (*c*) from Ohio and an oblong wild form (*d*) from Montgomery County, Md.

Golden Gem (Plate IX *b* —R. L. Martin, Borden, Ind.).—Roundish or slightly oblong, medium to large in size; color dark orange to red; seeds few; flesh soft, very sweet and rich; free from astringency even if picked before fully ripe. Commences to ripen about the last of August and continues till October. This variety was brought to notice by Mr. Logan Martin, of Borden, Ind., who found the original tree on his farm 35 years ago. He has propagated from this by budding, and now has more than 300 trees, including top-worked wild and young trees growing in the nursery.

He reports that the persimmon pays him better than any other fruit. The trees bear annual crops and the fruit finds ready market in Chicago and Indianapolis at $1 to $1.50 per 12 pint case, shipped by express. Some cases have sold as high as $2. Mr. Martin estimates the yield of a well-grown tree at 15 to 25 gallons per annum and the average price at 75 cents per gallon.

Marion (Plate IX *a*—Samuel Miller, Bluffton, Mo.).—Roundish oblate, large, dull red, with rather tough skin and few seeds. Quality good, though less rich than some. Season October. Original tree found near Fulton, Mo., on land owned by Mr. J. H. Marion. Tree productive and a vigorous grower, with very large, thick leaves.

PAPAW.

Not much has yet been done in improving this fruit by selecting desirable types for propagation and cultivation. Some interest has recently been manifested, however, and a few nurseries offer the trees for sale. It is valuable both as an ornamental tree and for its fruit. Specimens of choice varieties of this native fruit, *Asimina triloba*, have been received from several localities. Mr. D. Snow, of Chicopee, Mass., sent ripe specimens of medium size that were borne by a tree which he grew from seed about 35 years ago. They were of pleasant flavor and good quality, though less rich than fruit of the same species received from Ohio and Missouri.

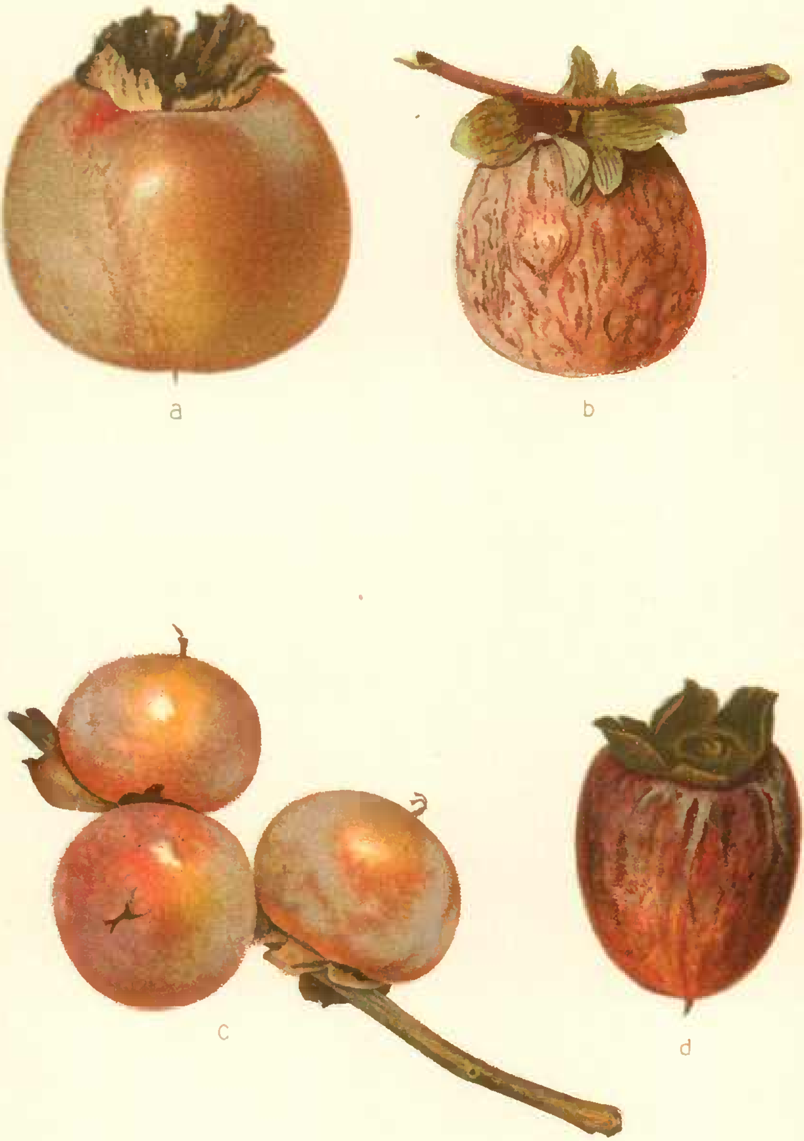
Mr. Snow states that the tree has made a vigorous growth and seems hardy in his location. It commenced flowering when 10 or 12 years old, but did not bear fruit until several years later. Since then it has borne good crops. The fact that Chicopee is a considerable distance north of the range of natural distribution of this species gives this tree special interest to the fruit-grower.

Mr. Henry W. Hope, of Paint, Ohio, sent specimens of the papaw that were large and of very excellent quality and have the merit of ripening early. Mr. Hope reports a tree of this species in his neighborhood the trunk of which is 40 inches in circumference at 1 foot from the ground.

NUTS.

ALMOND.

Jordan (Charles Heath, ex-consul at Catania, Sicily).—Large, smooth, with thick, hard shell and a single, long, plump kernel of fine quality. Almonds of this variety are imported only as kernels and come to the United States principally from Malaga,



PERSIMMONS.

a - Marion b - Golden Gem
c - Seedless Wild d - Oblong Wild

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Spain, being mainly grown on the islands in the Mediterranean, off the coast of Spain. They are highly esteemed on account of their large size and pleasant flavor. They sell for 8 or 10 cents more per pound than other almonds in our markets. The commercial name "Jordan" is a corruption of the French "jardin," meaning "garden." An effort to grow this variety in this country is worthy of the attention of California almond-growers.

CHESTNUTS.

Dager (J. W. Killen, Felton, Del.).—A seedling of the Ridgely; larger and perhaps better than the parent. The original tree is about 40 years old and stands on the farm of Mr. Dager, near Wyoming, Del. It is now being propagated by grafting.

Felton (J. W. Killen, Felton, Del.).—Is a large and very sweet nut, the best in quality of any Japanese chestnut thus far received. It possesses those edible qualities which are lacking in most other chestnuts of the Japanese type.

EUROPEAN HAZEL.

Jones (J. W. Killen, Felton, Del.).—Short, roundish, of medium size; quality good. Shrub fruitful, hardy, disposed to sprout a good deal from the root. The foliage has thus far been free from mildew and other diseases in Kent County, Del.

SHAGBARK.

Eliot (A. J. Coe, Meriden, Conn.).—Pyriform, with sides considerably corrugated; size medium; shell thin; cracking qualities good, though not best; kernel plump, not very oily; flavor mild and pleasant. This was the product of a grafted tree. It was awarded first prize on its merit as a nut, with few competitors, at the Connecticut Agricultural Society meeting at New Haven, December 19, 1892.

PECAN.

Where not otherwise specified, the varieties were sent by Arthur Brown, of Bagdad, Fla.

Alba.—Size below medium, cylindrical, with pointed apex; cracking qualities good; shell of medium thickness; corky shell lining thick, adhering to the kernel; kernel plump, light colored; quality good.

Biloxi (W. R. Stuart, Ocean Springs, Miss.).—Medium size, cylindrical, pointed at each end; surface quite regular, light brown; shell thin; cracking qualities medium; kernel plump, with yellowish brown surface; free from astringency, of good quality, and keeps well without becoming rancid. Introduced several years ago by W. R. Stuart as Mexican Paper Shell, but the name has since been changed to Biloxi.

Columbian (W. R. Stuart, Ocean Springs, Miss.).—Large, cylindrical, somewhat compressed at the middle, rounding at the base; pointed and somewhat four-sided at the crown; shell rather heavy; cracking qualities medium; quality good. In size and form this nut closely resembles Mammoth, which was introduced in 1890 by Richard Frotscher, of New Orleans, La.

Early Texan (Louis Biediger, Idlewild, Tex.).—Size above medium, short, cylindrical, with rounded base and blunt conical crown; shell quite thick, shell lining thick, astringent; cracking qualities medium; kernel not very plump, of mild, nutty flavor; quality good.

Georgia Melon.—Size above medium, short, rather blunt at apex; cracking quality medium; shell rather thick; kernel plump, brown; meat yellow, moderately tender, pleasant, good.

Gonzales (T. V. Munson, Denison, Tex.).—Above medium size; with firm, clean shell; quality excellent. Originated in Gonzales County, Tex.

Harcourt.—Size medium, short, slightly acorn-shaped; cracking qualities medium; shell rather thick, but very smooth inside; kernel short, very plump; meat yellow; very tender; rich; very good.

Longfellow.—Size medium, oblong, cylindrical, somewhat irregular, enlarging from base to near crown, then sharply conical to the apex; cracking qualities not first-class; shell of medium thickness; kernel plump but rather thin, light-colored; meat white; sweetish, rich; good.

Primate (W. R. Stuart, Ocean Springs, Miss.).—Of medium size, slender, rather long; shell thin; quality good; ripens in September, thirty days before other nuts.

Ribera.—Size above medium; oblong ovate; cracking qualities good; shell thin; kernel plump, light brown, free from the bitter, red, corky growth which adheres to the shell; meat yellow; tender; with rich, delicate, pleasant flavor.

Turkey Egg, Sr.—Large, long, pointed; cracking qualities very good; shell of medium thickness; kernel long, plump; brownish yellow; separates readily from the shell; meat yellow, a little tough; not of highest quality.

Turkey Egg, Jr.—Smaller and shorter than the above; cracking qualities medium; shell of medium thickness; kernel plump, light colored; tender; oily; rich; good.

Unnamed wild (H. G. Hodge, York, Ill.).—Above medium size, with quite blunt ends, rather thick shell and good kernel; this is a promising variety for trial in the north, as it is the best one yet received from any point north of the Ohio river.

Probable hybrid (H. G. Hodge, York, Ill.).—Large and angular; many specimens obovate, resembling some forms of *Hicoria glabra*, the hull and shell much like *Hicoria ovata*, though the buds and leaves are more like *Hicoria sulcata*. Cracking qualities good. Kernel full, plump, and of superior quality. Worthy of propagation. Tree 80 feet high and 2 feet in diameter.

BLACK WALNUT.

Gordon (R. D. Buford, Buford City, Va.).—The largest black walnut thus far received at this office. Form cubical, slightly conical at each end; shell of medium thickness; cracking qualities good; kernel light colored, plump; quality excellent. Tree 3 feet in diameter and 60 feet in spread of branches. Planted by John Gordon, a Revolutionary soldier, who located in Bedford County, Va., prior to 1812. Many seedlings from this tree have been planted in other portions of the State, and some of them are reported to bear as good nuts as the original

Missouri (J. H. Rose, Galt, Mo.).—Oval, compressed, of medium size, with quite smooth shell, which cracks well; kernel light colored, plump; flavor pleasant, delicate, quite free from the grossness characterizing the common black walnut; quality very good.

REPORT OF THE CHIEF OF THE DIVISION OF MICROSCOPY.

SIR: I have the honor to submit herewith my annual report on the work of the Division of Microscopy for the year 1893.

Very respectfully,

THOMAS TAYLOR,
Chief.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE YEAR.

EXHIBIT OF THE DIVISION AT THE WORLD'S FAIR.

The numerous and constant demands, both by correspondence and by personal inquiry, for information in regard to mushrooms, including not only methods of cultivation but the means of identifying the various species found in field and forest, indicated so widespread an interest in this subject that it was deemed advisable to prepare for the World's Columbian Exposition at Chicago an exhibit which should illustrate, by models, as many of the leading genera and species of the edible and non-edible mushrooms of the United States as could be collected.

In connection with the exhibit a catalogue has been prepared, which describes each species represented. This undertaking necessitated a large amount of correspondence and divisional field work, as well as a personal supervision of the details of the exhibit. There was also prepared an exhibit consisting of the instruments of precision used in the routine work of the division, and of a series of magnifications of microphotographs showing the characteristic crystallizations of animal and vegetable fats. Aside from this, the division was represented in the cotton exhibit of the United States Government by a large selection of types of foreign and domestic cotton, collected for the division by the cotton exchanges of this country and Liverpool, England. The entire exhibit of the division covered a space of over 500 square feet. The mushroom exhibit is now installed in the museum of this Department.

Cordial acknowledgments are due to agricultural experiment stations and other collectors from whom have been received specimens of the mushrooms of their respective localities; also, to the National Museum for specimens of various animal fats.

A MUSHROOM HERBARIUM.

As an aid to the identification of species and as a means of facilitating exchanges of specimens, it has long been desired to form a herbarium which should comprise such species of mushrooms as admit of

preservation for that purpose; but until within the last few months the division has been so cramped for room as to render it impossible to preserve a large number of specimens for any length of time. However, several hundred plants, representing many edible and poisonous varieties, have been preserved partly by drying and partly in alcohol; and since the division has been installed in its present more roomy quarters, the nucleus of a herbarium has been formed, which is at present augmented by the loan, by Dr. T. A. Taylor, formerly of the District of Columbia but now of Omaha, Nebr., of a collection consisting of several thousand dried specimens, chiefly the Hymenomycetes, in which are included most of the fleshy mushrooms.

MICROSCOPICAL INVESTIGATIONS.

Microscopical investigations have been made of suspected butters, lard, oleomargarine, milk, olive oils, etc., as requested from time to time by the public.

Samples of the teas of India, Ceylon, Russia, and Japan, and coffee from Costa Rica, have been secured from the various commissioners from these countries at the Exposition at Chicago. These samples are valuable for use in contrast when examining such teas and coffees on the market as are suspected of adulteration. Samples of animal and seed oils of many varieties have also been obtained from Russia, Japan, Ceylon, Spain, Turkey, Australia, Trinidad, Liberia, Costa Rica, and the Argentine Republic, together with twelve samples of native olive oils from California. These pure oils from original sources are of special value, as types of reference, in pursuing the micro-chemical investigation of the adulterations of the medicinal and food fats, already successfully inaugurated in this division.

INVESTIGATION OF THE COTTON STAPLE OF THE UNITED STATES.

For the purpose of conducting an investigation of the cotton staple of the United States the division has been furnished with 141 samples of cotton from reliable sources, principally from experts connected with the cotton exchanges of New Orleans, Texas, Savannah, and Liverpool, England. The samples from Liverpool represent all the more important cotton-growing countries exclusive of the United States. Nearly 3,000 measurements have been taken, averaging generally 20 to the sample, giving the maximum, minimum, and mean length of the fibers of the sample.

MEASUREMENT OF COTTON FIBERS.

Each individual hair of cotton seed is known commercially as a cotton fiber. As seen under the microscope each such hair has a blunt point, the natural termination of the fiber, differing from its opposite extremity, which shows the fracture occasioned in picking and ginning. We proceed to measure by first mixing and pulling apart loosely a few ounces of cotton, drawing out of this at random one fiber and placing it upon a glass slide previously moistened with a little weak gum water. The fiber is then gently and carefully smoothed with a camel's hair pencil and the fingers until straight. This is accomplished under a dissecting microscope with low powers.

When straightened, the fiber is viewed with the compound microscope, using a magnifying power of about 400 diameters, in order to ascertain

whether its natural point is present. If wanting, which is exceptional, the fiber is discarded. A glass micrometer 2½ inches long, divided into thirty-secondths of an inch, the lines ruled so as to be visible through the glass, is then placed over the slide holding the fiber, and its length ascertained by close and careful inspection. It will be seen in the above explanation that only fibers which show a terminal point are measured. This criterion for measurement was adopted after testing the results upon individual fibers of the method in use among cotton experts. They have a rough method of determining the length of the fiber in a given sample, viz, by taking a bunch of the cotton firmly between the thumbs and forefingers of both hands and pulling it apart with great force, passing layer over layer repeatedly until the fibers are fairly even. The sample is then laid on the coat sleeve for convenience and its length taken with a pocket rule. This hasty method results in a breakage of about 50 per cent of the individual fibers, the microscope showing that after the violent process described about that proportion exhibit fracture at both ends, whereas the fiber as delivered from the gin ordinarily, as has been shown, shows fracture at but one end, especially where the roller gin is employed.

The method adopted is to ascertain, first, that the fiber is a proper subject for measurement, and then to take the average length of a given number of fibers in each sample. The number of linear measurements having been made, the next step is to ascertain the width, twist, elasticity, and tensile strength. The names of growers and measurements of samples thus far examined are withheld, lest injustice should be done other cotton-planters whose samples have not yet been measured. It is the purpose to compare the staple of this country with that of foreign countries, noting what changes, if any, occur in cotton raised from American seed on foreign soil, especially as regards Sea Island staple, observing also whether Egyptian seed grown in this country produces a staple of similar grade to that produced in Egypt.

The prosecution of this investigation of cotton staple will constitute an important feature of the divisional work of the year 1894. The measurements of cotton already effected are but a small proportion of the work to be done.

FOUR EDIBLE MUSHROOMS.

RUSSULA VIRESCENS Fr.

(Edible.)

A considerable number of this species were collected in Prince George County, Md., during the months of June and July. Our experience as regards color, structure, and habitat of this mushroom agrees with that of Prof. Peck, who describes it under the name of *Russula virescens* Fr., as follows:

> According to the description of this species, the margin of the pileus should be even, but specimens occur sometimes in which the margin is wholly or partly striate. The number of forked and intermediate lamellæ is also variable, and the "warts" are sometimes pale brown instead of green. The color of the pileus is generally grayish green, but is frequently tinged with yellow.

The term "warts" used in this connection refers merely to the patches resulting from the splitting or breaking of the epidermis of the cap, and not to such excrescences, called "warts," as are commonly observed

on the cap of *Amanita muscarius*, for example, which are portions of the volva. A trial cultivation of this species is recommended. It has been found growing in Maryland from June to November, but hitherto seems to have attracted but little attention in this country as an edible species, although highly esteemed in Europe, and according to some authorities susceptible of cultivation. The peasants in the neighborhood of Milan are in the habit of toasting these mushrooms over wood embers, eating them afterwards with a little salt. The light green color of the top, resembling the pigment "terre verte," may have caused some distrust as to the edibility of this species, but special attention is called to it as one of the most desirable mushrooms we have for food.

EXPLANATION OF PLATE I.

Plate I exhibits four views of this mushroom drawn and colored from nature. Fig. 1, the immature plant; Fig. 2, advanced stage of growth, cap expanded or plane; Fig. 3, section showing the unequal length of the gills and manner of their attachment to the stem; Fig. 4, surface view of the pileus, showing a slightly umbilicate tendency in maturity and the epidermis split in characteristic irregular patches; Fig. 5, spores white.

COPRINUS COMATUS Fr.

(Edible.)

This species, *Coprinus comatus*, is found in abundance in the United States, in rich soil, usually in the fall months. It was offered for sale for the first time during the present season in Center Market, Washington, D. C., bringing 25 cents per pound. This species is highly esteemed, especially for catchups, for which it is largely used in England when there happens to be a dearth of *Agaricus arvensis*, or the "horse" mushroom. Prof. Peck describes our American species thus:

Pileus thin, cylindrical, then campanulate, rough, with broad, rather distant, fibrous scales, whitish, margin soon discolored, revolute and lacerated; lamellæ linear, crowded, free, white, then pink, finally black; stipe nearly equal, fibrillose, hollow, annulate, the annulus or ring movable; the cavity of the stem containing a gossamer-like web.

EXPLANATION OF PLATE II.

Plate II represents a fragile and perishable species, the gills of which soon dissolve into an inky fluid, by which feature the genus is readily identified. In the plate Fig. 1 shows the very young plant; Fig. 2, stage of growth in which the cap begins to expand, exposing the tender pink of the gills; Fig. 3, mature plant, bell-shaped and "maned," with movable ring detached from the pileus, and with stem unequal and rooting; Fig. 4, sectional view, showing hollow stem, thin cap, and broad, free, linear gill; Fig. 5, spores black.

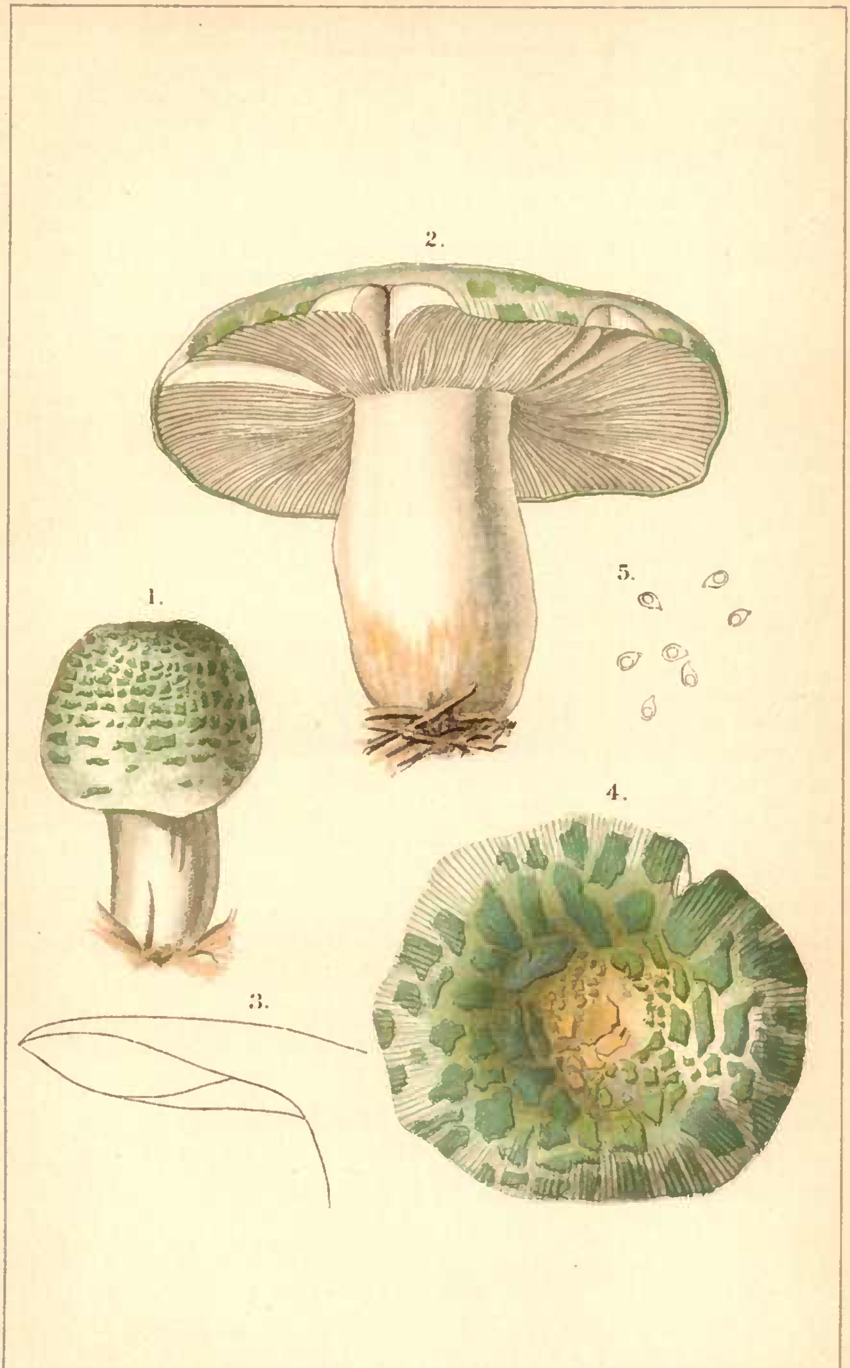
MARASMIUS OREADES Fr. "Fairy Ring Mushroom."

(Edible.)

This mushroom, found in hedges and orchards from May to October, belongs to a non-putrescent genus and dries readily. The cap of *Marasmius oreades* is of a pale ocherous tint, shaded sometimes with rufous or reddish brown. Stem and gills are of the same color.

This species is described by Prof. Peck as follows:

Pileus fleshy, firm, smooth, convex, then expanded, often irregular and broadly subumbonate, watery, fulvous when moist, whitish or cream-colored when dry; lamellæ broad, distant, free, whitish or cream-colored; stipe equal, smooth, solid, sometimes rooting. I have never seen it forming a complete ring, but it often forms a part of one.



L. Krieger, Pinx. AVIL CO LITH. PHILA

RUSSULA VIRESCENS, FR. (EDIBLE)
The Verdette, from Nature.
Collected in the District of Columbia.

L. Krieger, Pinx.

AVIL CO. LITH. PHILA.

COPRINUS COMATUS FR. (EDIBLE)
The Maned Mushroom, from Nature.
Collected in the District of Columbia.

L.K. after Gillet.   AVIL CO. LITH. PHILA.

MARASMIUS OREADES FR. (EDIBLE)
The Fairy Ring Mushroom.

A. (HYPHOLOMA) SUBLATERITIUS Schaeff.
Edible. Collected in the State of Maryland.

EXPLANATION ON PLATE III.

In Plate III Fig. 1 represents an immature plant; Fig. 2, cap expanding with growth; Fig. 3, cap further expanded and slightly umbonate; Fig. 4, mature specimen, cap plane or fully expanded, margin irregular and smooth, stem equal, smooth, and ringless; Fig. 5, section showing gills broad, free, ventricose, unequal, and flesh white; Fig. 6, spores white.

AGARICUS (Hypholoma) SUBLATERITIUS Schæff.

(Edible.)

Some of the older authors deemed this a poisonous mushroom, but it has been frequently eaten by the writer and others in quantity without bad effects. This species is very plentiful in Prince George County, Md., where a stump measuring from 3 to 4 feet in height literally covered with these mushrooms was recently observed. They grow in pine and oak woods in groups of 50 or more, and are generally found on rotting tree stumps.

EXPLANATION OF PLATE IV.

This plate represents a group of wild, edible mushrooms, found in great abundance in the fall of the year and even as late as January, frequently in such dense clusters that only their caps can be observed.

The cap of *Agaricus sublateritius* is of a brick-red color, with edges pale straw. Gills at first a dirty white, turning in advanced age to a dark olive green. The stem tapers downward, and within an inch of its attachment to the cap is of a very light straw color. Towards the root it is covered with patches and lines of burnt sienna color. Uncooked it has sometimes a slightly bitter taste, which disappears when it is stewed with butter, pepper, and salt.

CRYSTALLIZATIONS OF SEED-OIL FATS AND ANIMAL FATS.

Recent investigations demonstrate that the crystalline forms of the animal and vegetable fats differ materially. To illustrate this in some degree, two plates of vegetable fats are submitted in contrast with one plate of animal fats. To obtain crystals of the fatty glycerides of animal fats, the melted fat should cool gradually for about ten hours in a temperature of about 65° F., in order to get the fully developed crystallization. The fat of plants will crystallize within as many minutes.

CHAULMUGRA FAT (extracted from the seeds of *Gynocardia odorata* R. Br.).

For the purpose of securing interesting and beautiful groupings of the crystals of seed fats, the method here outlined must be strictly followed; otherwise, some of the forms illustrated can not be obtained. The solid fat used in the production of the crystals seen in Plate V, Fig. 1, was secured from the oil of chaulmugra seed. (For further information concerning the medicinal properties of this seed oil see No. 29 of the Imperial Institute Series, published by the Indian department of revenue and agriculture.) In preparing chaulmugra fat for micro-photography put a small portion of it on a microscopical slide, placing over it a glass cover such as is used in general mounting. Heat the slide over a spirit lamp until the fat melts—do not overheat—and allow it to cool in a temperature of about 60° F. Within a few minutes the mount will appear white, owing to the crystallization of the fat. The slide is now ready for observation under the microscope. The same slide may be reheated and allowed to cool, giving similar results. Although various crystallizations of this fat are obtained, all exhibit sameness of minutiæ

of crystallization. It is found that heating chaulmugra fat to the fuming point causes, it would seem, a dissipation of some volatile glyceride, thereby changing the crystallization; therefore, this fat should not be submitted to fuming heat, as is the method with the animal fats.

COCOANUT OIL.

Plate v, Fig. 2, represents an oil from Colombo, Ceylon, derived from the seeds of a species of palm known botanically as *Cocos nucifera*. The oil which is obtained from the seeds, either by hot pressure or by boiling the seeds in water, is of a butyraceous consistency, white, and of rather a peculiar odor. The extensive geographical distribution of this tree is accounted for by the fact of the tree growing in such close proximity to the sea that the ripe fruit, falling on the beach, is washed away by the waves and afterwards cast upon distant shores, where it readily vegetates. It has been said that in this way the coral islands have become covered with these palms. It is also worthy of remark that the triangular form of the fruit facilitates its progress through the waves.

CARAPA, OR "CRAB" OIL FAT.

Carapa or "crab" oil is expressed from the seeds of a tree native to tropical America, the West Indies, and Guinea. Plate vi, Fig. 1, represents the crystallizations peculiar to "crab" oil fat. The sample of oil from which the fat was extracted for the illustration came from the island of Trinidad. The oil is suitable for illuminating purposes, and, it is said, is also used by the natives of tropical regions to anoint the hair. In cool temperatures this oil hardens into a solid fat. Botanically, the tree from which this oil is obtained is known as *Carapa guianensis* Aub.

"PALM-OIL" FAT.

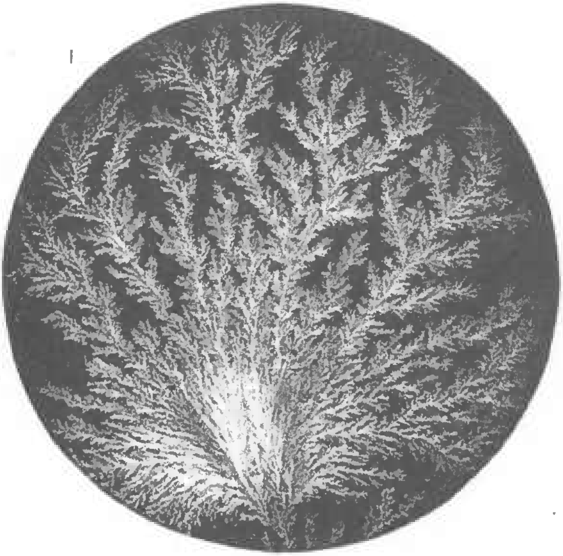
Plate vi, Fig. 2, represents the crystallized fat of "palm oil," obtained from the seeds of a species of palm tree native to western tropical Africa, *Elais guineensis*. The sample was received directly from Liberia, on the coast of Africa.

ANIMAL FATS.

Plate vii represents six animal fats, including one view of human fat. Fig. 1 represents the crystallization of cow's-butter fat. This smooth, rounded form is very frequently met with in testing butter of the Shorthorn breed of cows. Fig. 2 represents the forms very frequently observed in butter from the Jersey breed; the crystallizations generally exhibit an uneven outline. Fig. 4 shows the crystallizations of a butter from a cross-breed of Jersey and Shorthorn; Fig. 3, muskrat-fat crystals; Fig. 5, human-fat crystals; Fig. 6, fat crystals of a monkey which died of consumption. Several fats of this tribe received from the National Museum, recently tested, including the fat of an ourang-outang, yielded the same characteristic crystals (stearin). It has been found that stearin is a less soluble fat than palmitin, hence it seems probable that palmitin is more readily absorbed at a high temperature of the blood, than stearin. (*See* Fig. 6.)

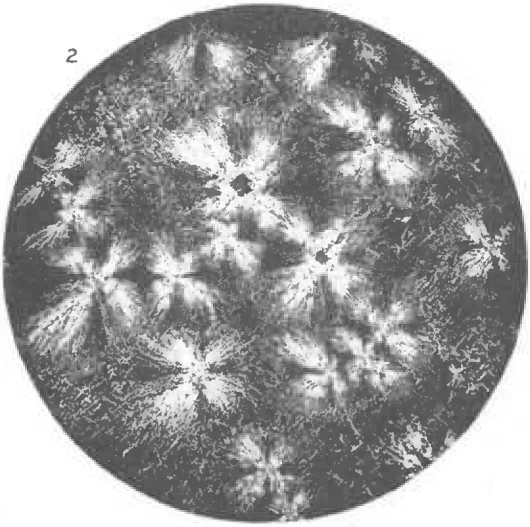
CHAULMUGRA FAT CRYSTALS.

1



COCOA-NUT FAT CRYSTALS.

2



Heliolithogravure. The Orcutt Co. Chicago.

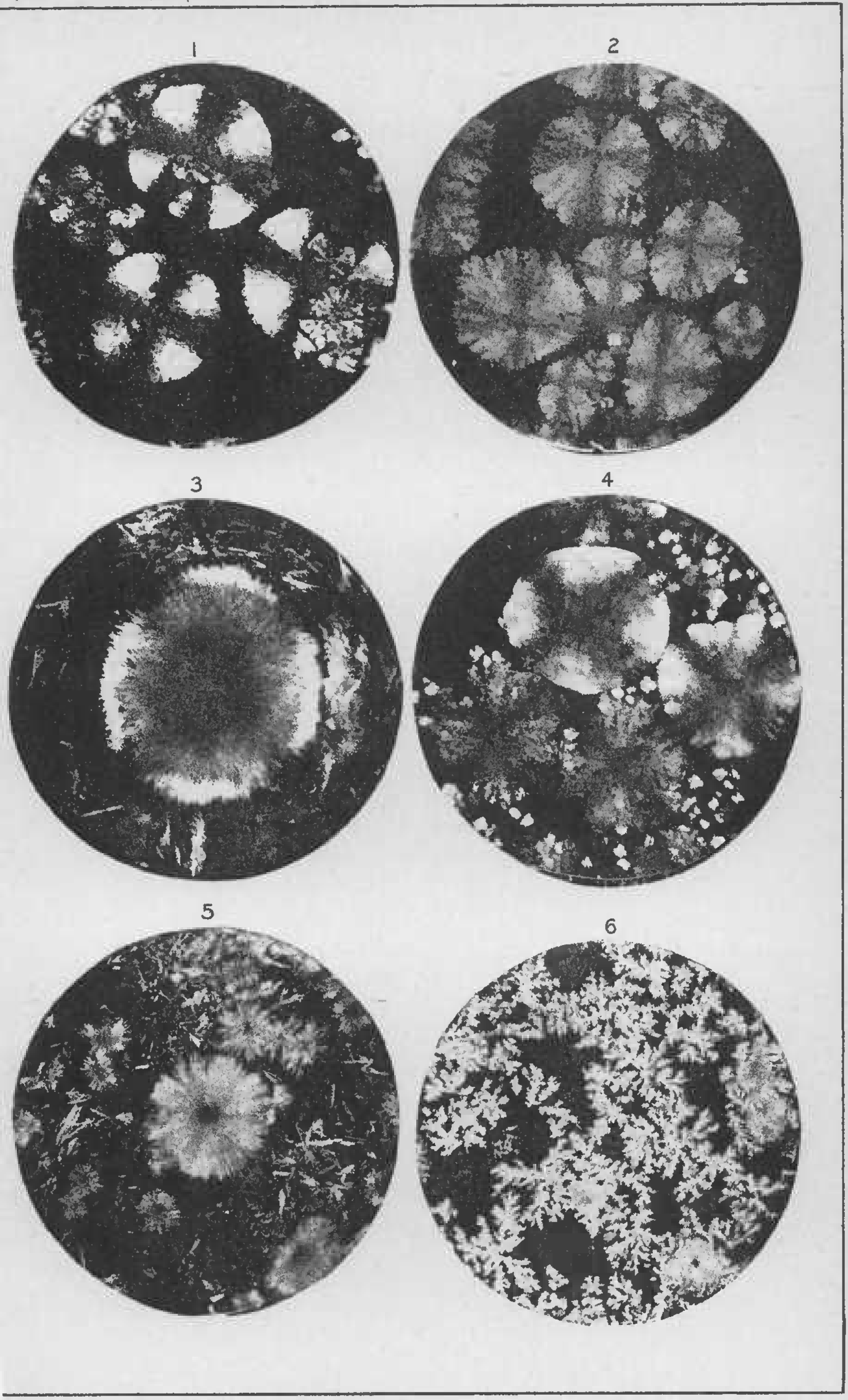
CARAPA FAT CRYSTALS.

1

PALM FAT CRYSTALS.

2

Heliolithogravure. The Orcutt Co. Chicago.



Heliolithogravura. The Orcutt Co. Chicago.

1. 2. 4 Cow's Butter Crystals.
3 Musk-Rat Fat "
5 Human " "
6 Monkey " "

REPORT OF THE CHIEF OF THE DIVISION OF FORESTRY.

SIR: I have the honor to submit my eighth annual report upon the work of the Division of Forestry, including also a presentation of the methods of German forest management as illustrated at the World's Fair.

Very respectfully,

B. E. FERNOW,
Chief.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE YEAR.

OFFICE WORK.

The increase in the correspondence of this division, in answer to inquiries for information on general and specific subjects, as noted in former reports, has continued during the present year. The demands thus made on the time of the writer and of the office force in general can of course be met only by neglect in other directions, namely, the pursuit of special lines of investigation and the preparation for publication of such material as has accumulated. Hence many reports and bulletins, the publication of which has been contemplated and promised from year to year, still await the editorial hand to fit them for publication. The delay in this latter respect may not always be considered detrimental, since with new information added in the course of time the reports can be made more complete and satisfactory, but it is annoying sometimes, when information asked for exists on file in manuscript and can be furnished only by typewritten copy, absorbing much time of the clerical force. The need, alluded to in the last report, of an increased office force in the direction of experts who can give advice in technical matters and are, in addition, endowed with a sense of that literary perspective which renders them fit for editorial work, still exists and in an increased degree.

TIMBER INVESTIGATIONS.

The major part of the funds of the division has been devoted, the same as last year, to the timber investigations, for which an increased appropriation had been granted, and which have continued to present the most practical and useful work for the division to undertake.

The first results of the investigations have been made public in a progress report, being Bulletin 8, or Part II of the series which is to be continued under the caption of "Timber Physics." It comprises

some of the results of mechanical tests on longleaf pine, and also of chemical analyses and other inquiries designed to determine the influence of turpentine orcharding on the timber of that species. While these results are of interest and conclusive as far as fixing the range of strength of the species, establishing beyond doubt the influence of the degree of seasoning as well as that of specific weight on strength, determining also beyond question the absence of influence on strength of the heartwood due to bleeding, in other directions they must be taken only as indications by no means definitive, and the discussion of the results is only tentative and an earnest of what is to follow when the data can be more carefully correlated.

In work so comprehensively planned and carried on with such a small force, the accumulation of data alone necessarily occupies the longest time, and generalizations from the same must be delayed rather than hastened, lest the mistakes of the past which it is proposed to correct be thereby repeated. The main result of this year's work, then, resumed after several months' discontinuance for lack of funds, has been the accumulation of additional data on the pines of the South. There have now been collected and in part tested and examined altogether 370 trees, from 16 different stations. Of these, 24 are Northern pines, 65 oaks of 7 different species, 23 bald cypress, and the balance of 258 belongs to the four important Southern pines (longleaf, shortleaf, loblolly, and Cuban), with collections from Arkansas, Texas, Louisiana, Alabama, Georgia, and South Carolina; the longleaf pine receiving the lion's share, with 117 trees, from 9 stations and 10 different sites.

Thanks are again due to the various railroad companies, whose generosity in transporting test material free of charge has made it possible to handle much larger amounts than our funds would otherwise have permitted. Especially are we under obligation to the management of the Louisville and Nashville Railroad, over whose lines nearly all material collected enters St. Louis. Not less generous support has been given by the East Tennessee, Virginia and Georgia Railroad Company from the East, while the Iron Mountain and Southern Pacific roads kindly furnished the transportation from the Southwest.

The results of physical examinations of the longleaf pine for 43 trees from four sites have been compiled by Mr. Roth and will be ready for publication shortly. The principal points of interest brought out so far may be summarized as follows:

The rate of growth in height of this pine (*P. palustris*) is similar to that of the white pine (*P. Strobus*); it is greatest between the fifteenth and fiftieth year; the height of the ordinary merchantable trunk, 60 to 70 feet, is usually attained at or before the age of 60 to 70 years, while 90 to 100 feet may be regarded as a fair average height for this species. The rate of growth in volume of the timber is fairly constant after the age of 60 to 70 years, but of course the increase in diameter becomes correspondingly slower with age, so that old trees add but about one-half as much to their diameter each year as do trees of 125 years and less—an observation of economic value to the operators of large tracts of pine lands. From these and other considerations it appears that the species may possibly be managed with an average rotation of about 100 years, producing then the largest amount of good milling timber per acre, while for heavier timber the rotation would have to be extended to 160 years.

It also appears from numerous determinations, measurements, and tests that the position of the European foresters in maintaining as a

general law that coniferous wood of slow growth is better than that of rapid development does not apply to this species. It also appears that the wood produced by young trees, 50 to 100 years old, is of better quality than that laid on by trees 200 or more years old, much excelling it in its specific weight and consequently in its strength and resistance.

In selecting lumber of this kind for particular purposes the proportions (or relative width) of dark brown bands of summer wood marking the outer part of the yearly rings will be found the safest criterion for the specific weight and the strength of both the sap and heart wood, so that, with the exception of so-called "light wood," the weight and strength of seasoned wood varies with the color effect, the wood of the lightest color being also lightest in weight and inferior in strength. In the same way the wood in the interior of an old tree is heavier and stronger than that near the periphery. The wood of any given period of years decreases in weight upward, so that the wood of the upper logs of the same period of growth is lighter and furnishes less durable and weaker material as was indicated in published results of the preliminary examinations. Water forms about 16 to 20 per cent of the weight in the fresh heartwood and 45 to 50 per cent of the sapwood. It appears to be more abundant in the sapwood of old than that of young trees and also more abundant in the sapwood of the upper parts of the trunk than of the lower.

The shrinking and swelling of this wood in drying or in soaking is found to be greater in the sapwood than in the heartwood, greater in heavy than in light wood. The average values, from which there are many slight exceptions, indicate that the shrinkage as a per cent of the fresh volume is—

In heartwood about 15 per cent of specific gravity × 100, in sapwood about 20 per cent of specific gravity × 100; i. e., if the specific gravity of a piece of heartwood is 0.60, the shrinkage per cent may be placed at 15 per cent of 60 = 9 per cent, and if the piece were sapwood, its shinkage per cent would be 20 per cent of 60 = 12 per cent.

These generalizations seem warranted by the results of experiments on carefully prepared pieces measured with caliper, and also determinations on microscopic sections, which latter especially leave no doubt as to the influence of weight—amount of substance in a given volume—on the shrinkage of the tissue, notwithstanding the contrary opinions expressed, even of late, and by such acknowledged authority as Dr. Nördlinger and others.

This timber-investigation work has met with the highest appreciation and praise, not only from those concerned in its results, from the domestic technical press, and from a special committee of the jury of awards at the World's Fair, but also by the reviewers of the same in foreign technical journals, one of whom, himself in charge of similar work for the Prussian Government, uses the following language in the leading forestry journal (Danckelman's Zeitschrift, 1893, p. 536):

This plan of work is as remarkable for its scope as for consistent pursuit of an eminently practical result. Although Germany has accomplished a great deal in some directions of this field, especially in investigating the laws of growth and wood structure, we are yet far from having such a comprehensive and indispensable knowledge even of our most important timbers. We must admit, with a certain sense of humiliation, that the Americans show us what it is we really ought to know, and that they have already by far surpassed us in the elaborate organization for these investigations.

Nevertheless, it has become apparent that in the practical execution of the plan there are discrepancies which necessitate some changes

in methods. The local separation in three different places of the test work, the physical examination, and the direction, which occasioned friction, delay, and lack of mobility, has in part been remedied by the transfer of Mr. Roth to Washington, where, however, only temporary and insufficient facilities for the physical laboratory can yet be secured.

The growing collection of study material, unique in the world, is too valuable to be left, as now, in a wooden shed, liable to conflagration at any time; nor are the accommodations and facilities available for the work sufficient or suitable. These disadvantages should be removed as soon as possible. It has also become apparent that a more careful division of the test work will have to be made into what might be called wholesale or commercial testing and testing for the finer correlations, especially between structure and qualities. This last necessitates a careful subdivision of the test material according to judgment in each case, which can not be reduced to strict rule. Hence, at least part of the testing will finally have to be done under the immediate control and personal supervision of the investigator of the physical properties here at Washington. This is the more desirable when certain special minor investigations are to be instituted from time to time as called for. Of such investigations the following have been continued, begun, or planned during the year:

CHEMICAL ANALYSES OF WOODS.

In continuance of the work on the influence of bleeding for turpentine there have been made, under the direction of the Chemist of the Department, some 1,000 analyses of bled and unbled timber to verify the conclusions already reached, with results which leave no doubt as to the correctness of the former deductions. The material used for these analyses having been from collections that had been exposed to the air for a length of time, hence losing by evaporation unknown quantities of resinous matter, a new series of experiments has been instituted to determine the actual amounts and behavior of resins in the living tree, thereby furnishing data not only for a better knowledge of the physiology of resins, but also indications for a more rational method of turpentine orcharding.

The work on tannins has also had further attention. The opportunity afforded by the World's Fair of becoming acquainted with the tanning value of many materials, hitherto not at all or little known to the trade, led to the making of analyses of such materials exhibited. Some 70 materials—barks and woods—mostly from South America, were collected and in part analyzed. Materials of domestic origin have also been collected and are awaiting investigation.

There has of late years come about a change of methods in the construction of large storage houses, mills, etc., wood being substituted for iron or steel girders, because of the experience that the latter are more apt to lead to total loss of the building by fire than when wood, stone, or brick is used; the heat bending the metal beams out of shape, thereby occasioning a collapse, while burning wooden beams will remain in shape until their carrying power is destroyed. It is, of course, desirable in such structures to employ such kinds of wood as most resist destruction by fire, combining with this quality the necessary strength and the existence of available quantities and sizes. There have never, so far as we know, been any systematic experiments made to determine the relative inflammability and combustibility of various timbers; hence an investigation of these questions, appearing of considerable practical importance, has been planned and will presently be carried out.

Investigations into shrinkage and swelling, and into the effect of different modes of seasoning, are also in progress.

TREE MEASUREMENTS AND ACRE-YIELD DETERMINATIONS.

In addition to these laboratory investigations there has been begun a line of field work which branches over into the field of forest biology. This is a series of tree measurements and acre-yield determinations, which are to serve the purpose of ascertaining the rate of growth of various timbers under various conditions at various ages. This investigation is carried on in connection with the collection of test material in the forest, and supplemented by measurements on the test material itself at the laboratory. Besides on the pines of the South, such measurements have been begun on the spruce and white pine in Maine, where the division was fortunate enough to find a competent man available for the work in Mr. Austin Cary.

Coöperation with the New York State forest commission in this line of investigations has been initiated, and it is hoped that further coöperation in other localities can be obtained, in order to cover as much territory as possible.

Without the knowledge obtained in this manner we shall never be able to discuss forestal operations intelligently, least of all the question of profitableness of forest management, which can be answered only when knowing the productive capacity of the various species under different conditions.

Since some of the readers of this report may desire to make measurements of this kind for their own sake, or for the benefit of this division and forestry knowledge in general, the schedules used in the work, which have proved practical in the woods, are subjoined on the following pages. Blank schedules can be furnished by this office on application.

BOTANICAL WORK.

The botanist of the division was principally occupied with preparation and installation of exhibits for the World's Fair, and spent most of the time, while the Exposition lasted, in charge of the exhibit. The herbarium of the division has grown during the year by an addition of 500 specimens, and without any specific expenditure is gradually becoming valuable in the matter of series of material for comparative study of climatic influences in native and exotic forest trees. He has also prepared the material for and supervised the artists who are working on the plates which are to illustrate the monographs of timber trees so often promised and so long delayed in publication. It is hoped that they can be published, now much amplified, during the year.

The manuscript of the elaborate account of the endemic and exotic arborescent flora found in the District of Columbia, especially in the parks of the city of Washington, which was undertaken with assistance of funds from the National Museum, has in part been revised and is also to be published soon.

The revision of the nomenclature of North American trees, also completed in manuscript, still requires the attention of the botanist for eventual changes as new knowledge comes to light. It has been thought best to delay the publication until the need of possible changes grows less and a more settled policy as to the rules of nomenclature to be followed has been adopted by botanists. To turn this delay into an advantage it is proposed to add to the synonymy descriptive matter, which will make the publication more widely useful.

SCHEDULE FOR MEAS-

Strip No. *2.*
Station *B.*

<table>
<tr><th rowspan="3">Species.</th><th>Diameter, classes</th><th colspan="2">Over 36 inches.</th><th colspan="2">30-36 inches.</th><th colspan="2">24-30 inches.</th><th colspan="2">18-24 inches.</th></tr>
<tr><th></th><th>Over</th><th>Under</th><th>Over</th><th>Under</th><th>Over</th><th>Under</th><th>Over</th><th>Under</th></tr>
<tr><th>Height, classes</th><th colspan="2">120 feet.</th><th colspan="2">100 feet.</th><th colspan="2">100 feet.</th><th colspan="2">80 feet.</th></tr>
<tr><td rowspan="5">Pine</td><td>Number of trees</td><td></td><td>||||</td><td></td><td></td><td></td><td>|</td><td>卌||</td><td></td></tr>
<tr><td>Diameter and height of timber.</td><td></td><td>31×75
35×75
38×80
40×80</td><td></td><td></td><td></td><td>25×60</td><td></td><td></td></tr>
<tr><td>Merchantable lumber, feet, B. M.</td><td></td><td>1,200
1,300
1,800
2,900</td><td></td><td></td><td></td><td>900</td><td>300
450
450
500
350
300
300</td><td></td></tr>
<tr><td>Crown and bole development.</td><td></td><td>Large, but open, boles straight.</td><td></td><td></td><td></td><td>Good, full crown, bole crooked.</td><td></td><td></td></tr>
<tr><td>Totals { Numbers
Mass</td><td></td><td>4
7,200</td><td></td><td></td><td></td><td>1
900</td><td>7
2,650</td><td></td></tr>
<tr><td rowspan="5">Birch</td><td>Number of trees</td><td>||, about 70 feet high.</td><td></td><td></td><td></td><td></td><td></td><td>|, about 60 feet high.</td><td></td></tr>
<tr><td>Diameter and height of timber.</td><td>38×25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Merchantable lumber, feet, B. M.</td><td>1,000</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Crown and bole development.</td><td>Large, open crown.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Totals { Numbers
Mass</td><td>2
1,000</td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td></tr>
<tr><td rowspan="5">Maple</td><td>Number of trees</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Diameter and height of timber.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Merchantable lumber, feet, B. M.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Crown and bole development.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Totals { Numbers
Mass</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

URING ACRE-YIELD.

Site *a.*

14–18 inches.		10–14 inches.		6–10 inches.		3–6 inches.		Under 3 inches.		Remarks.
Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Totals, numbers, and mass.
80 feet.		80 feet.		60 feet.		40 feet.		20 feet.		
						卌 III	III		卌 卌 卌	
									卌 III	
						Clustered, but full crown.			*Dense, well limbed.*	
						8	*3*		*18*	*41* *10,750 feet*
							III		IIII	
										There is also a cluster of small balsams, 11 in number, about 3 inches diameter by 12–15 feet height.
							Small, straight.		*Light, open, straight.*	
							3		*4*	*10* *1,000 feet.*
					III				卌 I	
					Thin crown, slender.				*Quite thin, slender.*	
					3				*6*	*9*

BIOLOGICAL INVESTIGATIONS.

[Blank to be filled by collector.]

NAME OF SPECIES ——— ——— LOCALITY ——— ———

TREE NO. ——— POSITION: Crown free; partly free; crowded; SURROUNDING SPECIES: ——— ———

Dimensions.	Feet.	Inches.	Description.	Diameter at—	Inches.
				feet.	
Total height..........	....	....	The neighboring trees are........	4	
Length of timber......	....	....	....	8	
Length of crown	....	....	....	12	
Length of leader for the last five years ...	....	....	and stand.....................feet away respectively.	16	
			The timber of the tree is sound; defective; straight; crooked; wind-shaken; clear; knotty.	20	
				24	
				28	
				32	
				36	
				40	
				44	
				48	
				52	
				56	
				60	
				64	
				68	
				72	
				76	
				80	

Cross section.	Height of section from ground, feet.	Diameter of sections, centimeters.	Distance (in millimeters) from periphery to the limit of Groups No—										Sap-wood.		Thickness of bark, millimeters.	Total number of rings on section.
			1	2	3	4	5	6	7	8	9	10	Width, millimeters.	Number of rings.		
No.																
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																

NOTE.—For measurement of ring-growth across section metric measure is used to avoid fractions.
Name of collector: ——— ———.

Reduced results.

[Not to be filled out by collector.]

Age of tree.	Height from the ground.			Height.		In the—
Years.	Feet.	Inches.		Feet.	Inches.	Year.
			Here paste the graphic description.			10
						20
						30
						40
						50
						60
						70
						80
						90
						100
						120
						130
						140

INSTRUCTIONS.

Number trees measured in same camp and conditions consecutively; underscore descriptive words where given, whether standing free or crowded, or note briefly

other conditions of position and give surrounding species. Use 4-foot rule and gauge. In all cases, if possible, take two measurements of diameter at right angles and note average.

(1) Make notes as to crown and neighboring trees.
(2) Measure the total height.
(3) Measure the length of timber from stump to first crown-forming limb.
(4) Measure the diameters with calipers every 4 feet from the ground up.
(5) Count the rings on the stump, and on top of each log section, beginning at the periphery and marking every 10th one with pencil, and note for each cross-section:
(*a*) Height from ground and diameter.
(*b*) Total number of rings.
(*c*) Thickness of bark.
(*d*) Width of and number of rings in the sap-wood.
(*e*) Lay on the rule and note the distance from the periphery of the wood (not bark) to the limit of the 1st, 2d, etc., group of rings, or to the 10th; to the 20th; to the 30th, etc., rings.

NOTE.—If the rings are over 2 mm. wide, measure them in groups of 10 rings; if less than 2 mm., measure in groups of 20 rings.

DISTRIBUTION OF HAND COLLECTIONS.

The exhibit of American woods at the World's Fair started quite a demand for hand collections by public institutions and private individuals. To satisfy such demand as far as the means of the division allowed, the blocks of wood remaining over from various collections (some 4,000) stored at the Department were shaped into small pieces and were properly labeled, divided into a number of collections, and distributed, the object of this distribution being to stimulate interest in the study of our timber wealth, especially in schools and colleges. Full collections were exchanged for similar favors with the Forestry Institute of St. Petersburg, Russia; Tokio, Japan; and Eberswalde, Prussia; and in addition some fifteen sets were sent on application to public educational institutions and individual applicants. Some few sets remain for future disposal.

SEED AND SEEDLING DISTRIBUTION.

Under the provision of the law directing the distribution of "valuable economic tree seeds and plants," some 300 pounds of various seeds in 4,000 packages were distributed to 500 applicants, mostly from the prairie and Western States. In addition some 5,000 cuttings of superior strains of osier willows were sent to State experiment stations and to some one hundred individual applicants. Some 5,000 seedlings of black walnut, grown for the Department on the grounds of the Maryland Agricultural Experiment Station, are now available.

As has been repeatedly urged, the practical results derived from this provision of the law, at least in its present form, are of little value in proportion to the expenditure of money or energy—outlays which appear almost wholly a waste.

The object of such distribution can be only twofold, namely, to encourage forest-planting and to test the adaptation of certain kinds to certain climatic or soil conditions. There is no doubt that the supply of plant material could be made an effective incentive to the settler on the treeless plain; not that the cost of the material is of so much moment to the settler in many cases, but the inconvenience of procuring it and the uncertainty of obtaining proper material often deters him. But since forest-planting means planting on large areas and requires a large number of plants to the acre, the scale on which such

an adequate distribution must be made appears at once as a practical barrier to a successful use of the scanty appropriations set aside for this division. As shown elsewhere, even if the distribution had been confined to the timber-claim planters—an unjust discrimination—and not more than enough material for 1 acre were furnished (a small enough encouragement), the amount to be spent in that direction would have to be not less than $150,000.

Other countries much smaller than ours use this means of encouraging forest culture, with a full realization of the fact that to be effective it must be on a tolerably large scale; thus, the Prussian forest department furnishes from its nurseries some 40,000,000 seedlings free of charge and 24,000 pounds of seed at nominal cost; the council of agriculture in Bohemia (5,500,000 inhabitants), in coöperation with agricultural and forestry associations and individual estate-holders, distributes from 3,000,000 to 4,000,000 plants and 1,500 pounds of seeds. The cantonal governments of Switzerland (2,700,000 inhabitants), besides giving subventions for reforestation to the amount of $25,000, furnish also 5,000,000 to 6,000,000 plants and 1,500 pounds of seed.

In addition to the impracticability from a financial point of view, there is also an objection on the ground that many kinds of tree seeds are apt to spoil quickly and do not bear storage and delayed shipment; and, on the other hand, seeds and young plants are often not properly handled by the inexperienced planter. Finally, the tardiness of results from the time of sowing to the appearance of the plants and their first growth will tax the patience of many beyond endurance, and discouragement rather than success is commonly the consequence.

On the other hand, if experiment with the introduction of new kinds or with the adaptation of well-known species to new localities is the object, it would be better to have this done by the experiment stations, which are better prepared to do such work, the permanency of which insures more continued observation, and their public character, moreover, warrants more effectual dissemination of any experiences gained. The only proper manner, then, it appears, of complying with the provisions of the law is not a promiscuous distribution of plant material, but a coöperation by this Department with the various State agricultural experiment stations, or, since these are mostly well enough endowed to work in their own way, the same method is available as was pursued in the forest-planting experiment on the sand hills of Nebraska. Reference to this experimental planting was made in the last two reports of this division, in which it was pointed out how the division, in coöperation with private individuals who furnish land and labor free of charge, may undertake *bona fide* experiments, the division supplying plans and material. A number of such stations distributed through several States would eventually furnish object lessons and experiences in proper proportion to the expenditure.

PUBLICATIONS.

The annual report of the Chief of the Division of Forestry for the year 1892, containing a brief history of the forestry movement in the United States and an extensive discussion of the turpentine industry, was published in a separate issue to the extent of 15,000 copies.

The following reports or bulletins remain in manuscript and unpublished, partly on account of the difficulty, alluded to in the beginning of this report, of finding the needed time for editorial revision: Mono-

graph of the white pine (*Pinus Strobus*), by V. M. Spalding; Monographs of the longleaf (*Pinus palustris*), shortleaf (*P. echinata*), loblolly (*P. Tæda*), and Cuban pines (*P. heterophylla*), by Charles Mohr; Monographs of the pitch pine (*P. rigida*) and red pine (*P. resinosa*), by William F. Flint; Monograph of the black spruce (*Picea Mariana*), and white spruce (*P. Canadensis*), by Kate Furbish; Monograph of the hemlock (*Tsuga Canadensis*), by A. N. Prentiss; Report on consumption of wood in the charcoal iron industry, by J. Birkinbine; Report on consumption of timber in mines, by F. P. Dewey; Report on physical and biological observations on timber of the longleaf pine, by F. Roth; Revision of nomenclature of North American forest trees, by G. B. Sudworth; Handbook of the arborescent flora of Washington City. An effort will be made to bring these long delayed materials to publication during the ensuing year.

Besides Bulletin 8, as progress report on timber physics, referred to above, there was published a bulletin (No. 7) on forest influences, which contains an extensive review of the systematic observations at forest meteorological stations in Europe and elsewhere, as well as a discussion of the influence which forests have upon waterflow and sanitary conditions.

A circular (No. 10) to lumbermen was issued, calling attention to the condition of forest supplies, pointing out the need of coöperation of those most interested in the perpetuation of these supplies in improving present methods of treating the same, and the manner in which this might be done, especially by legislation looking towards better protection of forest property against loss by fire and otherwise, a draft of a bill embodying the principal features of such legislation being added.

In reply to some statements in the public press by Mr. H. Gannett, of the U. S. Geological Survey, which were calculated to mislead the public as to the true condition of our forest areas and forest policy, the chief of this division had the honor of addressing to the Secretary of Agriculture a letter which was published in circular form. Since, however, correspondence from many parts of the country shows that this reply has not been as broadly disseminated as the original statements, which it is important to discredit, it is deemed desirable to give further publicity to the refutations of Mr. Gannett's statements, especially as they are accepted as true by ill-informed persons, to the detriment of the work of this division and the forestry movement in general.

Letter to the Secretary of Agriculture regarding forest growth and timber consumption.

ON BOARD S. S. ALLER, *April 5, 1893.*

DEAR SIR: Just as I was starting on my journey for the purpose of collecting an exhibit for the World's Fair, illustrative of the methods employed in German forest departments, a friend handed me an article published April 1 in the Evening News of Washington, over the signature of Henry Gannett, the chief geographer of the U. S. Geological Survey, in which the writer undertakes to show that efforts to bring about a more conservative and rational forest policy in the United States are unnecessary, because the relations of forest growth to climatic, soil, and water conditions are presumably of no practical significance, and because in his opinion the timber growth in the United States is certainly renewing itself much faster than it is being consumed.

Lest the assertions of this writer be given circulation without contradiction and thereby assume the dignity of authoritative statement, which may to some render it doubtful whether the work of the Forestry Division or of the American Forestry Association has been directed in the right channel, I take the liberty of addressing this letter to you, to be published if you see fit. The official position which I hold renders it incumbent upon me to arrest, so far as I may be able to do so, the promul-

gation of such false statements and inferences as are contained in Mr. Gannett's article; and since the tendency of the article is undoubtedly to throw discredit on the work of the forestry movement, and of the Forestry Division in particular, justice to them and to the division seems to require that public refutation be made.

That there is a certain amount of truth in Mr. Gannett's statements and arguments makes them only the more dangerous, for this little truth hides from ready discovery the misstatements and the flaws in the argument, and the public—not over critical—too readily inclines under their authority to erroneous conclusions. In the case of Mr. Gannett's statistics, the misfortune is that they can not indeed be met positively with absolutely correct data on the other side, but only negatively with the certainty of their incorrectness.

Briefly, regarding the status of our timber supply, Mr. Gannett states that the wooded area of the United States covers approximately 1,113,000 square miles (712,320,000 acres); that each acre produces annually 40 cubic feet of wood; that we consume annually between 20 billion and 24 billion cubic feet of wood (accepting the estimate made by the Forestry Division); that, therefore, no shortage is to be feared, but that an overproduction of from 6 billion to 10 billion cubic feet of wood takes place on this area.

Mr. Gannett has become more conservative regarding the forest area than he has been in former statements. He has asserted that 50 per cent of the United States is wooded; he now comes down to 37 per cent. The Forestry Division, by correspondence with well-informed residents in each State some years ago, ascertained the area under forest to be below 500,000,000 acres. But we may readily concede the larger area, simply remarking by the way that the failure to arrive at more certain figures is perhaps chargeable to Mr. Gannett's voice in shaping the policy of the last census, for he it was who objected to the present writer's contention that it would be proper for the census to gather forestry statistics.

As far as Mr. Gannett's estimates and calculations of woodland areas are concerned, they are wholly irrelevant to the question at issue, namely, the question of timber supply; for he overlooks entirely the character of such wooded lands as timber producers. The merest tyro in forestry matters, or any observant logger or timber looker, will be able to point out to Mr. Gannett the difference between waste brush lands, such as to my own knowledge are figuring in the estimates of the Geological Survey as woodland, and timber-producing forest growth. The one is occupied by woody growth, to be sure, but of kinds which do not grow to useful size or useful quality and which prevent by their very existence the occupation of the area by desirable timber-producing kinds, becoming thus a positive hindrance to useful forest growth. Here is one considerable element of uncertainty which Mr. Gannett entirely overlooks, thereby exposing an utter lack of knowledge regarding timber production. Again, the merest tyro in the science of wood growth is well aware that 40 cubic feet of annual growth of such character as enters into our wood consumption, and to which the accepted estimate of consumption of 20 billion feet refers, has nowhere been known, at least in the temperate zones, and, as an average, over an area of more than 700 million acres.

With more knowledge than Mr. Gannett in these matters, I venture to say that his figure exceeds at least three times the possibilities. How he arrived at his extravagant figures I am at a loss to understand. Since this question of wood growth per acre per year is of considerable general interest, I will explain its conditions more fully and cite statistics of more than usual reliability, which are fortunately available to me.

In the well-managed forests of Prussia (some 35,000,000 acres), largely stocked on poor land, the average total production of wood per acre for a long series of years has not been more than 21 cubic feet, but this includes branch wood, brush, and roots, which are not used in our country. Of this only 14 per cent, or hardly 3 cubic feet, represents material fit for the industrial uses; and we should add that in the United States firewood is also made from such material. In the Government forests of Prussia (some 8,000,000 acres), exemplary in their management, the production reaches nearly 6 cubic feet. The highest wood production in German forests is reported from Baden (over only 4,330,000 acres of forest) with somewhat over 50 cubic feet of wood per acre per year. Assuming also a larger per cent of sizable timber, namely 20 per cent, we would here find the annual production per acre of such material as we are in the habit of using at the rate of 10 cubic feet per acre. Competent writers on the subject, who believe that the Government reports understated the annual growth, have calculated the same to be as high as 55 cubic feet per acre (see report of Forestry Division, 1886, p. 184), of which they assume 27 per cent to represent wood over 3 inches in diameter; even this larger figure would bring the product of sizable wood to less than 15 cubic feet per year. And I repeat what is well known, that in the United States we hardly use the smaller sizes even for firewood.

To come now to more familiar measurements, we can figure out the possibilities or probabilities in the following manner, leaning toward extravagance rather than con-

servatism: Any lumberman acquainted with the various forest regions of the United States will admit that, leaving out the exceptional conditions on the Pacific coast, a cut of 20,000 feet (board measure) per acre from our virgin forests would be an absurdly large average estimate; this would represent, with excellent practice in the preparation of the material, say 2,000 cubic feet of round forest-grown timber, and since the trees cut to yield such material are at least 150 years old—they are in reality mostly over 200 years—the annual production would appear under such conditions as 14 cubic feet per acre per annum, or about as much as the most advantageous results reported from well-managed German forests.

Apply this most extravagant figure to the area as given by Mr. Gannett, and we find that our consumption at present is from 10 billion to 14 billion cubic feet in excess of what the area could possibly produce as an annual crop; or that we are cutting into our capital to the extent of more than 50 per cent of our consumption, and not, as Mr. Gannett would have it, that we are laying up for the future, which, by the way, increases the demands for wood material at the rate of more than 35 per cent every decade.

The above statements show clearly how utterly untenable is Mr. Gannett's position, and how evidently lacking he is in knowledge of the subject he discusses. Regarding his knowledge of the relation of forest cover to climate, soil, and waterflow, the same lack of familiarity with the real facts and their significance is apparent. As these will be fully brought out in a publication of the Division of Forestry (Bulletin 7) now in press, I will forego arguments in proof of this accusation, in order not to lengthen this letter.

One can not but deeply regret that men whose position before the public imposes upon them the responsibility of leading public opinion intelligently and upon the basis of well-established facts should thus be found ignoring their responsibility. I am encouraged to hope, however, that your well-known views regarding the rational and conservative use of our forest resources and the extension of forest areas where desirable will be strengthened rather than weakened by such groundless and unwarranted assertions by advocates of a policy of *laissez faire* in this matter.

Respectfully yours,

B. E. Fernow,
Chief of Division of Forestry.

Hon. J. Sterling Morton,
Secretary of Agriculture.

CONSUMPTION AND SUPPLY OF FOREST PRODUCTS IN THE UNITED STATES.

Regarding the supply of forest materials, which may be drawn from the virgin forests still in existence, we have no data. The difficulties of obtaining even the crudest approximations, except for certain species, as the white pine, the longleaf pine, the whitewood, etc., are not only great in the first place, for many reasons, but are still further increased by the fact that the methods of using the supplies change with their waning, with methods of transportation, and with other economic development. Thus the statistics of white pine and longleaf supplies, given by the Tenth Census in 1880, were as approximately correct as could be expected, adverse criticisms notwithstanding; but the lengthening out of the supplies, especially of the white pine beyond the time, when those figures foretold their practical exhaustion, has been possible only through the reduction of the average merchantable log by from 27 to 57 per cent—i. e., while during the census year in Wisconsin (Wausau) for instance, the average log was, say, 200 feet per log or 18 inches in diameter, in 1893 it had dwindled down to 84 feet or 13 inches in diameter. While the census statistics were based on the then practice of taking nothing less than 10 inches in diameter, the lumbering is now extended to logs as low as 5 or 6 inches in diameter.

No more striking statement of the decline in white-pine supplies could be made than to cite the number of feet in logs which passed the nine leading booms in the lower peninsula of Michigan in 1887, namely 2,217,104,985 as against 505,134,656 feet in 1893, a decrease of nearly 80

per cent, chargeable no doubt in part to other modes of transportation, but nevertheless foreshadowing unmistakably the practical exhaustion of supplies.

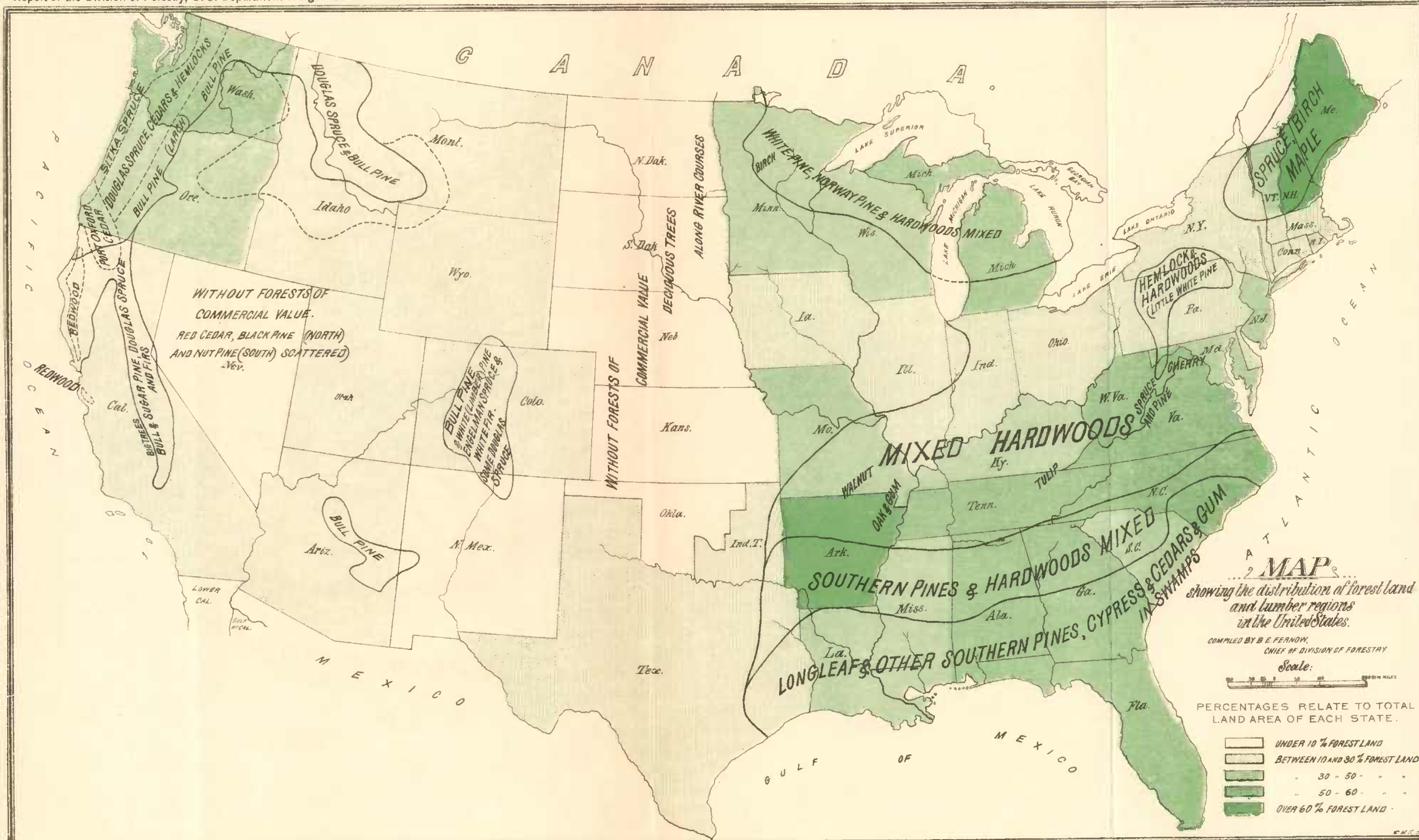
EXTENT OF FOREST AREAS.

While we can not then with any degree of even approximate accuracy speak of the amounts of standing and growing timber, we have somewhat better (although far from accurate) data of the forest areas, from which at least the capacity of wood production may be surmised, as has been done in the above-quoted letter in reply to Mr. Gannett's statements. But here, too, absence of knowledge as to the condition of these areas makes a statement of the actual supplies possibly on hand or growing mere guesswork. Not only are there to be distinguished the timber areas which contain supplies ready for the axe and for present consumption, but in the so-called second growth we must distinguish the areas which promise new supplies of value and those brush lands which are not only not growing a new timber crop, but on the contrary prevent the growth of timber and will for generations to come be mere waste lands, as has been pointed out in the above-quoted letter.

It will appear astonishing to those who have not paid attention to the question of the settlement of this country to learn from the subjoined table that while of the total country only 18 per cent is improved, the better developed eastern part (east of Colorado) shows only 29 per cent improved, and even the long-settled Atlantic coast which we are apt to consider fully occupied, still possesses 65 per cent of unimproved land, of which we estimate 43 per cent as woodland, while the percentage of woodland for the whole country is 25. There would be woodland enough to satisfy our needs for many decades if attention were but paid to its rational use and to the recuperation of the cut-over areas; but the condition of the wooded areas, which have been culled, is well known to be so poor, as far as market supplies are concerned, that for generations to come they must be left out of consideration.

The following table, compiled from the most reliable sources of information attainable and correcting any previous statements made by this division, is intended to give information as to approximate relation of improved land, forest and waste land, while the accompanying map (Plate I) shows by various grades of color the approximate relative proportion of forest to total area, and the character of the merchantable kinds of lumber that are derived from the different regions is indicated.

A second map (Plate II) shows more in detail the condition of that section of the country west of the 97° of longitude, which being largely situated in the dry region requires greatest attention to conservative forest use and contains still large areas of public timber lands. The information is derived from members of the U. S. Geological Survey and others acquainted with the region. It must not be overlooked, however, that these are not accurate surveys but approximations, and that a large per cent, often from 25 to 50 per cent of the area falling within the timberland or brushland area, is prairie, open country, waste land, or in cultivation. The location and size of the national forest reservations made under the act of March 3, 1891, have also been outlined on this map, suggesting a desirable extension of this policy.



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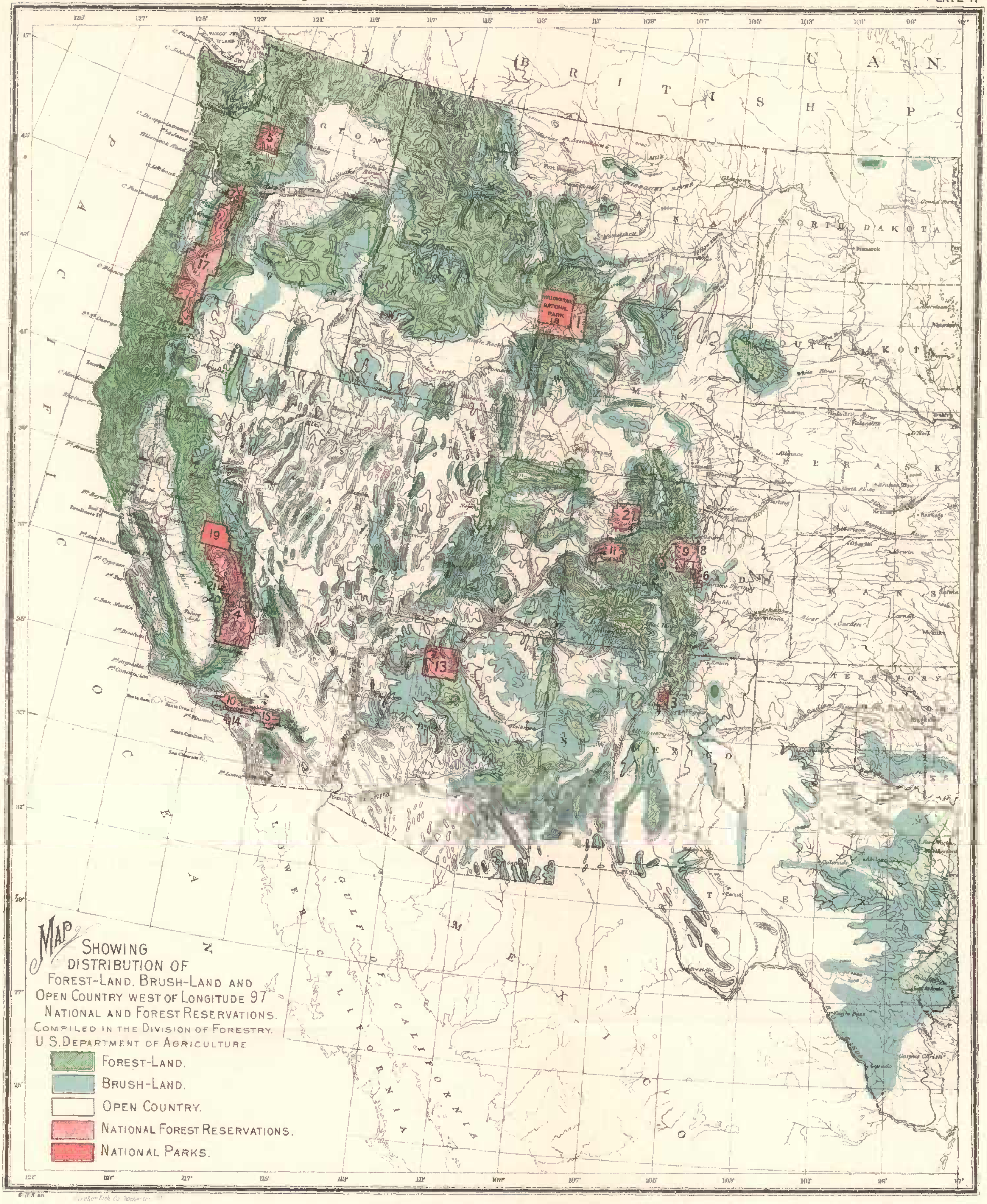

MAP
SHOWING
DISTRIBUTION OF
FOREST-LAND, BRUSH-LAND AND
OPEN COUNTRY WEST OF LONGITUDE 97
NATIONAL AND FOREST RESERVATIONS.
COMPILED IN THE DIVISION OF FORESTRY,
U.S. DEPARTMENT OF AGRICULTURE
FOREST-LAND.
BRUSH-LAND.
OPEN COUNTRY.
NATIONAL FOREST RESERVATIONS.
NATIONAL PARKS.
YELLOWSTONE NATIONAL PARK
P A C I F I C O C E A N
GULF OF CALIFORNIA
LOWER CALIFORNIA
M E X I C O
N E B R A S K A
K A N S A S
NORTH DAKOTA
SOUTH DAKOTA
W Y O M I N G
M O N T A N A
B R I T I S H P O S S E S S I O N S

Improved and forest land in the United States.

	Area.		Per cent.				
	Total land surface.	Improved land in farms.	Improved land.	Brush, forest, and waste land.	Probably forest.	Brush land.	Open country.
	Acres.	*Acres.*					
UNITED STATES	1,900,800,000	357,616,000	18	82	26	......	......
Maine	19,132,000	3,044,000	15	85	64	......	......
New Hampshire	5,783,000	1,727,000	29	71	62	......	......
Vermont	5,846,000	2,655,000	45	55	42	......	......
Massachusetts	5,155,000	1,657,000	32	68	29	......	......
Rhode Island	694,000	274,000	39	60	40	......	......
Connecticut	3,100,000	1,379,000	44	55	29	......	......
New England States	39,710,000	10,736,000	27	73	52	......	......
New York	30,376,000	16,389,000	54	46	30	......	......
Pennsylvania	28,790,000	13,210,000	45	65	24	......	......
New Jersey	4,671,000	1,999,000	42	58	41	......	......
Delaware	1,254,000	762,000	60	40	24	......	......
Maryland	6,310,000	3,412,000	54	46	32	......	......
Middle Atlantic States	71,401,000	35,772,000	50	50	28	......	......
Virginia	25,680,000	9,125,000	35	65	48	......	......
North Carolina	31,089,000	7,828,000	25	75	54	......	......
South Carolina	19,308,000	5,255,000	27	73	45	......	......
Georgia	38,647,000	9,582,000	24	76	50	......	......
Southern Atlantic States	114,724,000	31,790,000	27	73	49	......	......
ATLANTIC COAST	225,835,000	78,298,000	35	65	43	......	......
Florida	34,713,000	1,145,000	3	97	58	......	......
Alabama	32,986,000	7,698,000	23	77	53	......	......
Mississippi	29,658,000	6,849,000	23	77	44	......	......
Louisiana	29,069,000	3,775,000	13	87	45	......	......
Gulf States	126,426,000	19,467,000	16	84	50	......	......
Texas	167,808,000	20,746,000	12	88	23	......	......
Michigan	36,755,000	9,865,000	26	74	50	......	......
Wisconsin	34,848,000	9,793,000	28	72	47	......	......
Minnesota	50,691,000	11,128,000	21	79	36	......	......
Northern lumbering States	122,294,000	30,786,000	25	75	43	......	......
Ohio	26,086,000	18,338,000	71	29	16	......	......
Indiana	22,982,000	15,107,000	65	35	15	......	......
Illinois	35,840,000	25,669,000	71	29	10	......	......
Northern agricultural States	84,908,000	59,114,000	69	31	13	......	......
LAKE STATES	207,202,000	89,900,000	43	57	31	......	......
West Virginia	15,772,000	4,554,000	28	72	52	......	......
Kentucky	25,600,000	11,819,000	46	54	43	......	......
Tennessee	26,720,000	9,362,000	35	65	55	......	......
Arkansas	33,949,000	5,475,000	16	84	60	......	......
Missouri	43,990,000	19,792,000	45	55	36	......	......
Central States	146,031,000	51,002,000	35	65	48	......	......
Iowa	35,504,000	25,429,000	71	29	13	......	......
North Dakota	45,308,000	4,658,000	10	90	1	......	......
South Dakota	49,696,000	6,959,000	14	86	2	......	......
Nebraska	42,998,000	15,247,000	34	65	3	......	......
Kansas	52,288,000	22,303,000	42	58	7	......	......
Oklahoma	24,960,000	564,000	2	98	......	......	......
Prairie States	250,754,000	75 160,000	30	70	4	......	......
INTERIOR STATES	396,785,000	126,162,000	32	68	20	......	......

Improved and forest land in the United States—Continued.

	Area.		Per cent.				
	Total land surface.	Improved land in farms.	Improved land.	Brush, forest, and waste land.	Probably forest.	Brush land.	Open country.
	Acres.	*Acres.*					
Montana	92,998,000	915,000	1	99	18	20	61
Wyoming	62,448,000	476,000	0·7	99	12	16	71
Colorado	66,332,000	1,823,000	2·7	97	16	21	60
New Mexico	78,374,000	263,000	0·3	99	6	21	72
Eastern Rocky Mountain region	300,154,000	3,477,000	1	99	13	20	66
Idaho	53,945,000	606,000	1	99	20	40	39
Nevada	70,233,000	723,000	1	99		9	90
Utah	52,601,000	548,000	1	99	16	27	56
Arizona	72,268,000	104,000	0·1	99·9	14	12	74
Western Rocky Mountain region	249,047,000	1,981,000	0·7	99·3	8	22	69
ROCKY MOUNTAIN REGION	549,201,000	5,458,000	1	99	10	21	68
California	99,827,000	12,222,000	12	88	18	27	43
Oregon	60,518,000	3,516,000	6	94	34	28	32
Washington	42,703,000	1,820,000	4	96	55	21	20
Pacific coast	203,048,000	17,558,000	8	92	30	27	35

NOTE.—The authority for the area of improved farm land is furnished by the census of 1890. The areas of forest, brush, and waste lands were ascertained by subtracting the area of cultivated land from the total land areas of the several States, and are placed as per cent of the total areas in column 4. The part of these supposed to be forest is estimated on information obtained by various agencies. For the western section of the country the further subdivision into forest, brush, and open country is based partly on statistics gathered by Col. Ensign and published in Bulletin 2 of this division, partly on the map prepared as stated before and here published, and partly on timber estimates of the Puget Sound Lumberman.

INADEQUACY OF FOREST SUPPLIES.

In regard to the consumption of forest supplies no full statistics are available, yet we have a better basis for estimates. In the report for the year 1892 it was stated that the total annual consumption can not fall short of 22,000,000,000 cubic feet, or 350 cubic feet per capita, of all kinds of wood. This figure was arrived at by a series of careful estimates, the basis for which was stated. With additional information furnished by the Eleventh Census, it may be readily increased to 24,000,000,000 feet. The consumption of mill timber (sizable logs) was stated as about 4,000,000,000 cubic feet (now found to be an understatement by 15 per cent), representing about 30,000,000,000 feet, B. M., or between 20 and 25 per cent of the total consumption—a proportion which may be readily admitted to represent a rather extravagant average for the "millable" part of the forest growth, indicating that if we assume the annual growth of such timber per acre at 10 cubic feet (see Gannet letter), at least 400,000,000 acres of fully stocked forest are necessary to furnish this part of our consumption. Add the consumption of firewood, which is largely made of sizable timber, and it is safe to say that three times that area is necessary to furnish the amount of present consumption by its annual growth. From this statement alone, which is highly favorable to those who claim sufficient and "inexhaustible" supplies, the inadequacy of our forest area to meet growing demands will appear.

QUANTITY AND VALUE OF FOREST PRODUCTS.

The Eleventh Census statistics of lumber production, ably and conscientiously gathered by Mr. George A. Priest, agent of the census have not yet been published. Like all statistics of this kind, the figures given must be incomplete, always remaining somewhat short of the truth and requiring estimated additions. Nevertheless, they furnish gratifying proof that the above estimates by the writer are within bounds.

By the courtesy of the Superintendent of the Census, the Hon. Carroll D. Wright, the writer is permitted to produce, in advance of the regular publication by the census, a summary statement, prepared in part by Mr. Priest and supplemented by canvass and estimates of this division, showing approximately the variety, quantity, and value of forest products used in the United States during the census year.

Amount and value of forest products used during the census year 1890.

Classes of products.	Quantity.	Estimated cubic contents of forest-grown material.[2]	Value.
I. Mill products:[1]		*Cubic feet.*	
Agricultural implement stock .... feet, B. M.	30,000,000	....	$582,000
Bobbin and spool stock .... do.	49,000,000	....	688,000
Carriage and wagon stock .... do.	66,000,000	....	1,306,000
Furniture stock .... do.	94,000,000	....	1,435,000
All other sawed lumber .... do.	27,630,000,000	....	310,818,000
Total sawed lumber .... do.	27,869,000,000	4,000,000,000	314,829,000
Lath .... pieces	2,365,000,000	....	3,709,924
Pickets and palings .... do.	110,000,000	....	750,000
Shingles .... do.	9,276,000,000	200,000,000	17,000,000
Staves .... do.	1,178,000,000	300,000,000	7,762,000
Headings .... sets	183,000,000	175,000,000	4,934,000
Total lumber and cognate products, directly from logs	....	4,675,000,000	348,984,924
II. Railroad construction:			
Ties[3] .... pieces	80,000,000	400,000,000	....
Round and hewn timber used for bridges and trestles	....	80,000,000	....
Telegraph poles	....	5,000,000	....
Total	....	485,000,000	40,000,000
III. Exported timber not included in subdivision I:[4]			
Hewn timber, 6,900,000 cubic feet	....	9,000,000	1,230,000
Logs and round timber	....	2,500,000	2,000,000
Rived staves, stave and bolts	....	500,000	1,500,000
	....	12,000,000	$4,730,000
IV. Wood pulp:[2]			
300,000 tons ground paper pulp	....	75,000,000	3,550,000
80,000 tons soda pulp	....		
60,000 tons sulphite pulp fiber	....		
50,000 tons pulp for other purposes	....		
V. Miscellaneous mill products other than lumber manufactured directly from logs or bolts[5]	....	80,000,000	20,765,000
Total materials requiring bolt or log size	....	5,327,000,000	418,029,924
This last figure of "miscellaneous products" is a very considerable underestimate, based upon census returns and we are entirely safe in rounding off the total of sizable timber used and its value to	....	5,500,000,000	450,000,000
VI. Fuel[6] in the shape of wood	....	18,000,000,000	450,000,000
In the shape of charcoal	....	250,000,000	7,000,000
VII. Wood used for dyeing extracts and charcoal for gunpowder[5]	....	16,200,000	437,000
Total amount and value of wood consumption	....	23,766,000,000	907,437,000

Amount and value of forest products used during the Census year 1890—Continued.

Classes of products.	Quantity.	Value.	Total value.
VIII. Naval stores[5]—			
Turpentine .... barrels..	346,544	$5,459,115	....
Rosin .... do....	1,429,154	2,413,757	$7,872,872
IX[5]. Wood alcohol........ gallons..	2,000,000	1,750,000	....
Acetic acid in acetate of lime	....	360,000	2,110,000
X. Tanning materials[5]—			
Hemlock bark .... cords..	1,056,000	6,925,000	....
Oak bark........ do....	322,150	2,783,500	....
Hemlock and bark for extract .... do....	64,200	307,500	....
Sumac leaves for tanning .... tons..	3,300	198,000	....
Sumac leaves for extract .... do....	3,750	112,000	....
Various not accounted for........	....	74,000	....
			10,400,000
XI. Maple sugar........ pounds[5]..	32,952,927	3,300,000	....
Maple sirup .... gallons[5]..	2,258,376	2,200,000	5,500,000
Total value of forest by-products	....	....	25,882,872
Total value of all forest products........	....	....	933,319,872
Add 10 per cent for omissions and under estimates[2]	....	....	93,331,987
Total value of wood and forest products at original place of production, estimated to have been used during census year, 1890	....	....	1,026,650,859

[1] These data have been compiled by Mr. Priest from the reports of 21,011 establishments (representing probably 70 per cent in number and 95 per cent in value of product), of which 18,064 manufactured sawed lumber as principal product, 702 manufactured shingles exclusively, 438 manufactured staves and headings exclusively, and 1,807 used logs or bolts in the manufacture of the various classes of products stated under the head of "Miscellaneous," and corrected by the inclusion of the quantities used for customs sawing not given in the census figures.
[2] Estimated by the Division of Forestry.
[3] Canvass of Division of Forestry.
[4] From returns of Bureau of Statistics, U. S. Treasury Department.
[5] Based on figures of the 11th Census.
[6] Based on figures of the 10th Census and canvass of Division of Forestry.

The following interesting separation of mill products according to regions and kinds is given by Mr. Priest, the quantities being based on various returns, and hence somewhat at variance:

Lumber, of different kinds, sawed during census year 1890.

Kind.	Feet, board measure.
White pine........	11,300,000,000
Spruce and fir........	4,483,000,000
Hemlock........	3,390,000,000
Hard pine, cypress, etc........	5,516,000,000
Redwood........	317,000,000
Hardwoods and all other........	5,517,000,000
	30,593,000,000

Amounts and value of lumber sawed, in different sections of the United States, during census year 1890.

Region.*	Amount (M feet).	Value.
Eastern group	4,808,761	$51,939,519
Central group	3,129,988	44,407,296
Lake group........	8,250,702	98,110,488
Southern group........	4,926,331	46,790,542
Pacific group........	2,027,848	22,466,088
Miscellaneous	866,796	11,306,807
Total	24,010,446	272,020,740

* Eastern group comprises the New England and North Atlantic States; Central group, Ohio, Indiana, Illinois, West Virginia, Kentucky, Tennessee, Missouri; Lake group, Michigan, Wisconsin, Minnesota; Southern group, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Texas; Pacific group, California, Oregon, Washington; miscellaneous, all other States and Territories.

Imports of wood and wood products for home consumption during the years ending June 30, 1892 and 1893.

Articles.	1892.		1893.	
	Quantity.	Value.	Quantity.	Value.
Free of duty.				
Firewood........cords..	198,850	$411,482	199,187	$403,601
Logs and round timber		1,188,797		2,164,273
Railroad ties........number..	748,520	131,295	619,235	97,857
Shingle and stave bolts		44,387		53,505
Handle and head bolts		59,573		53,129
Ship timber		31,721		29,865
Ship planking		79,622		8,404
Hop poles		18,412		38,968
Wood for pulp-making		230,959		332,244
Charcoal		48,395		51,634
Cabinet woods; cedar, ebony, mahogany, etc		2,234,003		2,662,658
Cork bark		1,368,244		1,641,294
Hemlock bark........cords..	53,018	256,346	50,699	241,244
Bamboos, rattans, canes, etc		1,198,813		922,529
Briar root or briar wood, and the like, partially manufactured		39,185		40,470
Ashes		54,855		76,306
Fence posts		31,351		31,051
Tar and pitch of wood........barrels..	768	3,352	1,179	6,376
Turpentine, spirits of........gallons..	9,337	3,470	10,273	4,077
Turpentine, Venice........pounds..	36,642	3,992	20,694	2,365
Pitch, Burgundy........do....	281,430	4,386	207,220	3,558
Total free		7,442 640		8,865,408
Dutiable.				
Wood unmanufactured not specially provided for		32,655		25,952
Timber—				
Used for spars, wharves, etc........cubic feet..	12,295	2,301	9,432	943
Hewn and sawed........do....	445,804	54,570	1,419,484	62,868
Squared or sided not specially provided for.do....	14,036	1,392	65,139	492
Lumber:				
Boards, planks, deals and other sawed lumber........M feet..	482,339	5,588,948	529,263	6,283,805
Sawed lumber, not otherwise specified....do....	150,184	1,416,331	162,955	1,533,274
Sawed boards, planks, deals—cedar ebony, etc..	222	5,117	366	24,205
Clapboards........M..	6,259	99,187	7,072	113,988
Hubs, posts, laths and other rough blocks		29,823		28,227
Laths........M..	259,157	327,359	327,442	462,140
Pickets and palings........M..	3,157	22,679	5,483	36,700
Cedar poles, posts, and railroad ties........No..	2,115,986	259,583	1,815,949	271,236
Shingles........M..	362,551	731,299	470,001	916,759
Shooks		62,981		45,746
Staves		551,557		646,613
Manufactures, all others—				
Barrels or boxes containing oranges, lemons, etc., apart from contents		467,514		555,987
Casks and barrels, empty		919		531
Chair cane or reeds manufactured		181,337		173,967
Cabinetware and household furniture		411,712		382,199
Osier or willow, prepared for manufacture		82,633		64,427
Osier or willow, manufactures of		123,820		125,916
Wood-pulp........tons..	41,141	1,831,231	63,633	2,909,097
Veneers of wood		8,264		750
Bark extract, for tanning........pounds..	12,973	408	672	71
Sumac........do....	12,724,703	294,744	7,244,132	398,400
Corks and cork bark manufactured........do....	671,064	321,480	703,063	351,731
Matches		83,157		133,152
Frames and sticks for umbrellas		*92,437		*117,258
All other manufactures of wood or of which wood is the component of chief value		1,277,644		1,397,155
Total dutiable		14,364,100		17,163,589
Total imports		21,806,740		26,028,997

*Including other materials.

Exports of wood and wood products from United States for twelve months, ending June 30, 1892 and 1893.

Articles.	1892. Quantity.	1892. Value.	1893. Quantity.	1893. Value.
Agricultural implements:				
Mowers and reapers		$2,373,938		$2,873,897
Plows and cultivators		397,735		644,390
All other, and parts of		1,024,310		1,139,046
Bark and extract of, for tanning		239,708		232,269
Carriages and horse cars, and parts of		1,944,170		1,605,801
Cars, passenger and freight, for steam railroads ... No.	1,680	1,320,265	1,801	969,871
Ginseng ... lbs.	228,916	820,529	251,205	792,928
Matches		73,666		67,974
Oranges ... No.	11,856	772,582	12,518	897,870
Rosin ... bbls.	1,950,214	3,418,459	2,059,407	3,333,367
Tar ... do.	22,377	52,417	20,042	40,244
Turpentine and pitch ... do.	8,739	18,336	8,926	20,254
Turpentine, spirits of ... galls.	13,176,470	4,500,721	13,415,469	3,893,436
Fire wood ... cords.	423	1,604	1,920	5,877
Boards, deals, and planks ... M feet.	592,596	9,672,493	629,355	9,642,599
Joists and scantling ... do.	16,131	228,513	13,475	171,025
Hoops and hoop poles		88,222		40,350
Laths ... M.	7,893	17,717	3,461	8,663
Palings, pickets, and bed slats ... M.	640	6,259	387	3,854
Shingles ... M.	31,198	87,992	22,938	72,562
Shooks:				
Box		195,618		238,605
Other ... No.	412,308	585,919	385,863	702,403
Staves and headings		2,211,716		2,499,520
All other lumber		1,051,397		1,443,537
Timber:				
Sawed ... M feet.	235,550	2,673,154	214,198	2,320,123
Hewn ... cub. feet.	6,736,446	983,574	7,836,921	1,188,353
Logs and other timber		1,923,604		2,270,072
Doors, sashes, and blinds		295,918		273,455
Moldings, trimmings, and other house furnishings		202,589		208,002
Hogsheads and barrels, empty		290,113		218,880
Household furniture		3,090,146		3,112,291
Woodenware		356,553		328,817
All other wood manufactures		1,827,470		1,917,451
Total		42,729,407		43,097,786

Exports of wood and certain wood products during the year ending June 30, 1893, by districts of country from whence exported.

	Districts.* I.	II.	III.	IV.	Total.
Raw material:					
Boards, deals, planks, etc	$3,890,776	$1,883,450	$2,736,440	$1,131,933	$9,642,599
Joists and scantling	7,341	98,452	60,179	5,053	171,025
Hoops and hoop-poles	39,376	903	13	58	40,350
Laths	1,983	67	30	6,583	8,663
Palings and pickets	10	755	676	2,413	3,854
Shingles	18,909	35,792	16,556	13,015	72,562
Shooks	884,711	6,477	8,113	41,707	941,008
Staves	1,039,654	448,751	1,010,776	839	2,499,520
All other lumber	1,061,189	16,162	327,130	39,056	1,443,537
Timber (sawed)	147,052	352,633	1,441,565	378,873	2,320,123
Timber (hewn)	443,613	36,936	707,804		1,188,353
Logs and other round timber	928,393	1,028,092	303,763	9,824	2,270,072
Firewood	3,546		2,331		5,877
Rosin	615,028	2,711,032	14,366	2,941	3,333,367
Tar	27,585	11,546	1,045	68	40,244
Turpentine and pitch	17,291	2,212	63	688	20,254
Spirits of turpentine	431,717	3,455,904	664	5,151	3,893,436
Bark and bark extract	75,353	144,891	25	12,000	232,269
Total raw material	9,633,527	10,234,058	6,631,539	1,640,202	28,139,326

* District No. I includes all of the United States north of Baltimore and east of Rocky Mountains. District No. II includes the territory having its outlet by the South Atlantic ports. District No. III includes the territory adjacent to the gulf ports. District No. IV embraces that portion of the United States on the Pacific coast.

Exports of wood and certain wood products during the year ending June 30, 1893, by districts of country from whence exported—Continued.

	Districts.				
	I.	II.	III.	IV.	Total.
Manufactures:					
Agricultural implements	$4,504,914	$9,685	$106,469	$36,265	$4,657,333
Carriages and horse-cars	1,490,784	2,050	61,725	51,242	1,605,801
Cars, passenger and freight	790,771	....	179,100	....	969,871
Matches	57,852	80	3,689	6,353	67,974
Organs	875,877	13,560	3,220	5,213	897,870
Doors, sash, and blinds	206,304	5,522	6,547	54,082	273,455
Moldings, trimmings, etc	203,554	221	1,159	3,068	208,002
Hogsheads and barrels, empty	211,919	394	4,849	1,718	218,880
Household furniture	2,803,662	31,696	106,860	170,273	3,112,291
Woodenware	311,786	13,890	2,038	103	328,817
All other wood manufactures	1,628,170	144,842	82,736	61,703	1,917,451
Total manufactures	13,085,593	221,940	558,392	390,020	14,255,945
Total exports	22,719,120	10,455,998	7,189,931	2,030,222	42,395,271

FORESTRY EXHIBIT AT THE WORLD'S FAIR.

A large amount of the time and energy of the office force was occupied during the year in the preparation, installation, and care of the exhibit which formed a part of the Government exhibits at the World's Fair in Chicago. The subject of forestry, thanks to the active and intelligent interest of Mr. W. J. Buchanan, chief of the Department of Agriculture and Forestry, received a most important impetus at the Fair, which can not fail to advance the forestry interests of the country at a more rapid pace than hitherto.

By the construction of a separate artistically and characteristically designed building for forestry exhibits, the name of the subject, hitherto unknown to thousands or misunderstood, has become familiar, while in the elevation of the subject to the dignity of a department coördinate with the other large departments at the Fair, recognition was given to the great importance of the subject and a series of forestry talks, instituted by the chief of the Department, and a Forestry Congress under the auspices of the American Forestry Association, were designed to familiarize the visitors with the many aspects of the same.

This congress is especially worthy of note on account of the earnestness and thoroughly practical nature of its discussions, and particularly in the presence and participation, almost for the first time, of representatives of the lumber trade, with the result of opening their eyes wider than ever to the fact that the forestry movement is essentially vital to the interests of that trade.

This is not the place to dwell at length upon the many object lessons which were found in the Forestry and other buildings, an account of which is to form a part of a separate report by the jury of awards, of which the writer had the honor to be a member. The exhibit of this division, which is described somewhat in detail in another part of this volume, was designed, according to the law appropriating the funds for Government exhibits, to illustrate its functions. These are not of an executive character. Hence the division has nothing to do with any administration of the public or any other forests, being restricted to the study of the same and of all phases of forestry, with the duty of reporting results and giving such advice for the treatment of forest resources and refor-

estation as may be asked. It is, therefore, a bureau of inquiry and information, like most of the other branches of the Department of Agriculture.

ADVANCE OF FORESTRY INTERESTS DURING THE YEAR.

The year has been fruitful of signs which point to promising results in the near future of the efforts to establish a rational forest policy in this country. The policy of establishing forest reservations on the public domain has been further extended by the President's proclamation of the Sierra Nevada and Ashland Reserves, aggregating 4,511,360 acres. This makes the total acreage of forest reservations established under that title 17,564,800 acres.

List of national forest reservations and national parks of the United States.

No.*		Established.	Area.
			Acres.
1	Yellowstone National Park timberland reserve (Wyo.)	Sept. 10, 1891	1,239,040
2	White River Plateau timberland reserve (Colo.)	Oct. 16, 1891	1,198,080
3	Pecos River forest reserve (N. Mex.)	Jan. 11, 1892	311,040
4	Sierra forest reserve (Cal.)	Feb. 14, 1893	4,096,000
5	Pacific forest reserve (Wash.)	Feb. 20, 1893	967,680
6	Pike's Peak timberland reserve (Colo.)	Mar. 18, 1892	184,320
7	Bull Run timberland reserve (Oreg.)	June 17, 1892	142,080
8	Plum Creek timberland reserve (Colo.)	June 23, 1892	179,200
9	South Platte forest reserve (Colo.)	Dec. 9, 1892	683,520
10	San Gabriel timberland reserve (Cal.)	Dec. 20, 1892	555,520
11	Battlement Mesa forest reserve (Colo.)	Dec. 24, 1892	858,240
12	Afognak Forest and Fish Culture reserve (Alaska)	Dec. 24, 1892	Unknown.
13	Grand Canyon forest reserve (Ariz.)	Feb. 20, 1893	1,851,520
14	Trabuco Canyon forest reserve (Cal.)	Feb. 25, 1893	49,920
15	San Bernardino forest reserve (Cal.)	Feb. 25, 1893	737,280
16	Ashland forest reserve (Oreg.)	Sept. 28, 1893	18,560
17	Cascade Range forest reserve (Oreg.)	Sept. 28, 1893	4,492,800
	Total acreage of forest reserves		17,564,800
	NATIONAL PARKS.		
18	Yellowstone National Park	Mar. 1, 1872	2,142,720
19	Yosemite National Park	Oct. 1, 1890	967,680
20	Sequoia National Park	Oct. 1, 1890	161,280
21	General Grant National Park	Oct. 1. 1890	2,560

* The numbers refer to those used on map, Plate II.

The present great need of providing protection and suitable administration for these reservations is to be met by the enactment of a law (H. R. 119) which, while less comprehensive than that contemplated in the Fifty-second Congress (S. 3235), contains the essential features for a first step toward a more thorough organization, and recommends itself on account of its simplicity. Having been reported favorably by the Committee on Public Lands and placed on the calendar, its early passage, which is so necessary to a clinching of the policy expressed in the proclamation, is hoped for. This bill provides in the first place the use of the Army for protection of the reservations. Experience in Yellowstone Park and elsewhere points out the efficiency of such a service, which is also satisfactory to the officers and troops, as it breaks the monotony of camp life, furnishes useful occupation, and keeps the troops in practice for field work.

The next important provision lies in the authority given to the Secretary of the Interior to regulate the use and occupancy of the reservations, thus settling their legal status. The sale of ripe timber from

reservations and other public timber lands under such supervision as to insure the inviolability of the forest cover is also permitted, in the discretion of the Secretary. This provision, which has been severely criticised, is most important and essential to any kind of successful forest policy. Its absence from the statutes hitherto has been the fruitful source of depredations and forest destruction, for the resident population must be provided with wood material, and, in the absence of legal methods and fair means to do so, it is driven to supply its necessities by unfair means. As soon as a value is placed on the timber of the public domain it will be possible not only to dispose of it advantageously, but also to control the manner of its use without injury to the forest conditions and the future, and an interest in the same will grow up. In this or a similar provision, which attempts a rational use of the forest resources, lies the only salvation of our Western forests and of the soil and water conditions dependent on the same.

The funds derived from the sale of ripe timber and other income are to be set aside for the purpose of establishing gradually a more amplified and effective system of forest management, so that the forest itself shall pay for its own protection.

State Governments are also becoming more active in regard to their forestry interests. New Hampshire acted in part upon the recommendations of its investigating forestry commission, by making the same permanent (with a new personnel), constituting the selectmen of the several towns firewardens with power or allowing the commissioners to appoint special firewardens, the expense to be charged to town or county.

New York has passed new legislation having in view the final establishment of a compact State forest and also introducing some methods designed for the utilization of the spruce in the present State forest reserve. This last provision is faulty in that it is based on the misconception that restriction of the cutting to certain sizes is sufficient to preserve acceptable forest conditions.

Pennsylvania has passed a law establishing a well-considered plan of examining into the condition of its forest cover, especially at headwaters of rivers, with a view of formulating further action. The Pennsylvania Forestry Association, which represents by all odds the most active, business-like, and intelligent element in the forestry movement, has made this action possible; the association is thriving, increasing its membership constantly, and with the publication of its now nearly regularly issued "Forest Leaves" is the most powerful ally of the national association.

New Jersey is promising to enter the ranks of those States which recognize the importance of their forest areas, the first step being an examination by a committee of the State board of health into the needs of forest preservation on the highlands, the director of the Geological Survey having furnished the basis and first suggestion for such action.

Maine having inaugurated a tolerably satisfactory fire law, the northeastern Atlantic States seem to be in a fair way of establishing a forest policy.

In the West we have to note rather a retrograde movement. California found it necessary to abolish for political reasons its forestry commission, inaugurated eight years ago with so much promise, warranted by the eager and intelligent work of the first commission. Colorado also has practically abandoned its first attempts at a forest policy

by leaving the competent and useful forest commissioner without salary and means to proceed in his work.

Wisconsin has entered the ranks of forestry States by the inauguration of a forestry association starting upon a practical basis, which has in view the active coöperation of lumbermen.

The most notable event in the forestry movement, however, was, as in many other movements, its treatment at the World's Fair in Chicago.

GERMAN FOREST MANAGEMENT.

In addition to preparing the forestry part of the United States Government exhibits, it became one of the pleasing duties of the chief of this division to collect and install another forestry exhibit, to be placed in the Forestry Building for the German Government.

Upon the joint invitation of the Commissioner General for the German Empire and the chief of the Departments of Agriculture and Forestry at the World's Fair, and with the sanction of the Secretary of Agriculture, by whom the necessary furlough was granted, he undertook the honorable mission of collecting materials from the various forestry institutions of Germany, which might illustrate the methods and means of forest management and the status of forestry as a science and art in that country, acknowledged as leading in this particular branch of economics. The object of such an exhibit was more to acquaint our people with superior forestry methods than to attempt to show the progress and perfection to which forestry in Germany has attained. It was in the main to be an object lesson to our people and in that sense the coöperation of this Government in the manner indicated was readily given.

Accordingly the writer early in April visited the forest departments of Prussia, Saxony, Saxe-Weimar, Bavaria, Wurtemberg, as well as the leading forest academies and forestry schools (Eberswalde, Münden, Tharandt, Giessen, Eisenach, Tübingen, Munich, and Zürich) and selected such materials as would serve the purpose in view. In this undertaking, which on account of the short time left for it necessitated unusual expeditiousness, the writer received the most courteous, ready, and generous assistance from all the officers in charge of and in connection with the institutions above named, so that in less than two weeks the material was selected and within six weeks began to arrive in Chicago. There was of course no time to prepare anything specially for the purpose and only material on hand in the archives or study collections could be hurriedly gathered, to be finally shaped into an organic whole, representing a picture of the forest management of Germany. The cost of this journey and installation was borne jointly by the German Government and the World's Fair authorities.

A description of the exhibit, as finally installed by the writer, may serve the purpose of elucidating somewhat the methods of forestry as practiced abroad, and which, in principle at least, will have to be imitated in time by our people, as they have been by other nations.

MAP WORK AND FOREST DISTRICTING.

The first requirement in the management of any property is that all its conditions should be known and recorded. Hence a topographic survey of the forest district to be placed under management is the first requisite. Such survey refers not only to the boundaries and topo-

graphical features of the district itself, but also to the surroundings, especially with reference to connections with markets, and finally the geographical position of the forest areas in general grouped according to ownership. As illustrations of this last class of surveys there were exhibited:

Forest map of Bavaria;
Forest map of Wurtemberg.

These show in three different colors the forest areas belonging to the Government, to communities and institutions, and to private owners. From these it could be seen not only that the three classes of proprietors share about equally in the ownership of the forest area, but that the Government owns mainly the forests on the mountains where forest management must be carried on, not for profit, but for indirect benefits in the preservation of favorable soil and water conditions which therefore makes the permanent, well-organized management "by and for the people" necessary. Contrary to the notion to which currency is so often given in the United States, the various governments of Germany do not own more than 35 per cent, exercising partial control (so as to prevent destruction and waste) over only 15 per cent in the hands of communities and institutions, and leaving the balance of 50 per cent of the forest area in private hands almost entirely without restriction.

Sometimes the contours of the country are also indicated on the maps, which serves the useful economic purpose of permitting ready reference of the forest areas to the topography. As an instance of such work there was shown a

Relief map of Hesse.

On this the forest areas were indicated in green color.

For the sake of orderly administration, the whole country is separated into forest divisions or inspections (sometimes both) each of which forms a separate unit of administration. To indicate this subdivision there were exhibited:

Forest division map of Wurtemberg.
Forest district map of three forest inspections in the Spessart Mountains of Bavaria.
General forest map of forest inspection Bamberg-East, Bavaria.

It is to be understood that we are now speaking only of the Government forests, which are under a uniform general administration.

The administration of the Government forests is usually assigned either to the finance department (as in Bavaria) or to the department of agriculture and forestry (as in Prussia), with one director and council directly in charge under the supervision of the minister or secretary. The position of the director (Oberlandforstmeister) corresponds somewhat to that of our Commissioner of the General Land Office, except that, an extensive technical knowledge being needed in the position, the incumbent is promoted through all positions from the lower grades. Again, each forest division is placed under a separate administrative body consisting of an administrator (Oberforstmeister) with a council of forest inspectors (Forstmeister), each of whom has supervision of a number of the final units of administration, the forest districts (Oberfoersterei, Forstamt). The district officer (Oberfoerster, Revierfoerster, etc.), with a number of assistants, rangers (Foerster), and guards (Schutzbeamte), is then the manager and executive officer in the forest itself, while the higher supervising and inspecting officials are located at the seats of government.

SURVEY OF THE FOREST DISTRICT.

The survey of each forest district is carried out to the utmost minutiæ. To illustrate the methods pursued in Prussia we find first:

Special survey map of district Mühlenbeck.
Special survey map of district Rheinwalden.

These maps on the scale of 1:5000 appear in portfolio sheets, representing a careful survey by theodolite of the boundaries of the district, the permanent differences of soil and occupancy (roads, waters, fields, meadows, moors, etc.), and the division of the district into smaller units of management. This kind of map, of which only three copies are made, is then, for purposes of use in daily routine, reduced to a scale of 1:25000 on one sheet, and printed. The first matter of interest that strikes us on these blank or base maps is the division lines by which the district is divided into parcels or compartments. In the plain these lines divide the district into regular oblong compartments (Jagen) of about 60 to 75 acres each, with sides of 100 and 200 yards respectively, separated by openings or avenues which we may call "rides" (Gestell, Schneisse), so that the whole makes the appearance very much like the map of an American city regularly divided into blocks. The rides (from 8 to 40 rods wide) running east and west and north and south are lettered, the former, broader ones (main avenues) with capital letters, the latter (side avenues) with small letters, while the compartments are numbered. In the forest itself at each corner a monument of wood or stone indicates the letters of the rides and numbers of the compartments, rendering it easy to find one's way or direct any laborer to any place in the forest. The rides are often used as roads and serve also the purpose of checking fires, etc.

In the hill and mountain districts this regular division becomes impracticable and the lines of compartments conform to the contour, while the opening of the avenues is restricted to those which can be readily transformed into roads; roads, indeed, determining the division lines wherever practicable. To illustrate these various methods of subdivision there were exhibited:

Blank district map of Rüthnick, Prussia.
Blank district map of Mühlenbeck, Prussia.
Blank district map of Schulenburg, Prussia.

The first is a pine-forest district in the plain with rectangular compartments, the second a beech forest in the hill country, and the third a spruce forest in the Harz Mountains.

In hill or mountain districts topographic or contour maps become necessary, especially for the purpose of rational road construction, a matter on which in modern times great stress is laid and to which we shall refer later on more in detail. Such contour maps are sometimes executed in papier maché or gypsum models for readier reference. This class of work was shown by:

Relief model of range Buchholz, in district Mühlenbeck, Prussia;
Relief model of range Sonnenburg, in district Freienwalde, Prussia;
Relief model (small) of forest district Schulenburg, Prussia, with the corresponding contour maps;
Contour map of forest inspection Maut-West, Bavaria.

The instrument used in this work is one that would recommend itself for similar work in this country for expeditiousness, combined with sufficient accuracy (0·4 per cent); namely, the

Tachymeter, construction Fennel, with projecting apparatus.

The instrument, which was exhibited, is most compact and simple to handle, permitting direct survey of both distances and vertical contours in one motion, without any calculations; the former by means of a Reichenbach distance measurer, with stadia, the latter by a projecting apparatus (rectangular triangle) giving the horizontal distance, while a limb with nonius permits the reading of the azimuth.

For rapid preliminary work, such as the trial location of roads, various instruments are devised, which can also be used for measuring heights of trees, etc., of which the universal dioptra, construction Stoetzer, was exhibited. These are usually simple pendulum instruments.

Of late years a further refinement in the methods of reducing to paper the conditions of forest areas has been begun in Bavaria by the construction of soil maps.

Soil map of forest district Hauptmoorswald (Bavaria).
"The soil map and its significance for forest management," by A. Bauman.

These exhibits gave notice of this new departure. The above map, comprising 8,000 acres on a scale of 1:20000, shows by colors the kind of soil, and by signs its quality and depth of surface soil, character of subsoil and depth to ground water; black dots show the points actually examined. The notation is so simple that the conditions on any part can be readily read.

For instance, finding in one place of yellow shade, which denotes sand, the reading $\frac{\text{A. S. 190,}}{\text{G. W.}}$ we know at once that it is alluvial sand, 190 centimeters deep to ground water; while in the same area $\frac{\overline{\text{H 40}}}{\underline{\text{A. S. 30,}}}$ K L would tell us that the alluvial sand is overlaid by 40 centimeters of humus mold, and that the subsoil at 30 centimeters below the sand is impenetrable "Keuperletten" (clay).

PRINCIPLES OF MANAGEMENT.

The fundamental principles upon which the German Government forests and most of the communal and private forests are managed is briefly expressed in the idea that the forest growth is to be treated as a crop to be reproduced as soon as harvested, involving continuity of crops. To carry this principle into effect most advantageously the management must take care to husband the natural forces and conditions upon which thrifty forest growth relies, which leads to the second principle, that of highest efficiency of crops, or the two leading principles combined, to produce the largest amounts of material (or revenue) in the shortest time without impairing the condition and capacity for reproduction of the forest, perpetuating valuable forest growth wherever this is the best crop or where soil conditions make a forest cover desirable. In government forests in addition the financial principle prevails of treating the forest as a permanently invested capital, from which only the interest is to be used, making the amount harvested or the revenue derived to be as nearly alike from year to year or from period to period, and as nearly corresponding to the annual accretion, as it is possible to make them.

The present Oberlandforstmeister, or director, of the Prussian forest department uses the following language in laying down the principles upon which the government manages its forests:

The Prussian state forest administration does not accede to the principles of a continuous highest soil rent based upon compound interest calculations, but believes, in contradistinction to private forest management, that it can not avoid the obligation in the management of the state forests of keeping in view the welfare of the

whole community of citizens, and therein taking into consideration the need for continued supply of wood and other forest products as well as the other objects to which in so many directions the forest is subservient. The administration does not consider itself entitled to pursue a one-sided financial policy, least of all to submit the government forests to a pure money-making management strictly based on capital and interest calculations, but considers it its duty to so manage the forests as a patrimony belonging to the whole nation that the present generation may be benefited by the highest possible usufruct in satisfying its wants and deriving the protection which the forest renders, and that to future generations may be secured at least as large usufruct of the same kind.

To carry out these principles the intimate knowledge of the conditions of the property, referred to above, is necessary and is obtained by a careful forest survey as a basis for a systematic administration and forest regulation. As samples of the manner of acquiring and recording this knowledge the following exhibits served:

Manager's map of forest district Ruthnick, Prussia, representing conditions (pine forest in plain) and working plan in 1889.

Manager's map of forest district Muhlenberg, Prussia (beech forest in hill country), representing conditions and working plan in 1891.

Manager's map of forest district Schulenburg, Prussia (spruce forest in Harz Mountains), representing conditions and working plan in 1891.

Set of 4 timber maps of district Hauptmoorswald, Bavaria, showing conditions, respectively, in 1843, 1855, 1868, 1880.

Set of 6 timber and manager's maps of district Cunnersdorf, Saxony, showing conditions and working plans in 1829, 1854, 1862, 1872, 1884, 1890.

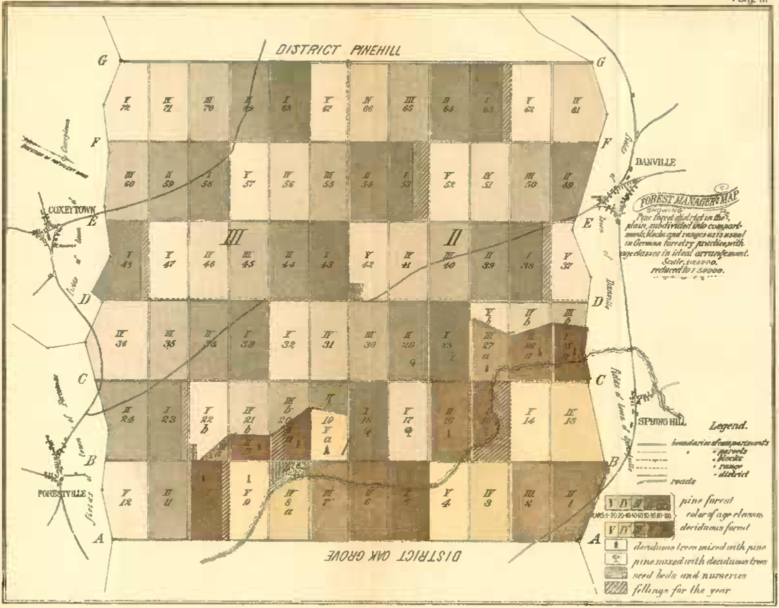
Set of 6 timber and manager's maps, reduced on one sheet, of forest district Timmlitz, Saxony, showing changes in conditions since 1822.

Forest survey, valuation, and regulation work, with plans of management and maps, of forest district Hinternah, Prussia (Thuringian Mountains), showing all changes and revisions from 1822 to 1880. Six volumes of manuscript and 7 maps.

The blank maps described above are used to denote on them all the data which the manager should have before him to readily determine the details of his management; that is, a description as complete as possible of the forest growth and its condition and the proposed manner of utilizing and reproducing the same.* This information—after further subdivision of the compartments where needed on account of differences in soil conditions or growth—is given by means of different colors, differences in shade, numbers, figures, marks, and signs. These maps, which are prepared after a most painstaking forest survey, and which we may call "manager's map" (Plate III), show at a glance not only the nature of soil conditions and what the principal kind of timber and its admixtures are in each compartment or subdivision, but also how old the growth; whether it is to be treated as a coppice, standard coppice, or timber forest; at what period in the rotation it is to be cut, and such notes as the manager himself may add from year to year, as, for instance, the yearly fellings, plantings, movable nurseries, new road projects, etc.

One of the most instructive exhibits in this direction was that showing the changes in Timlitz forest, Saxony. The map of the district in 1822 presented about the condition of one of our mismanaged Michigan forests of pine and hardwoods mixed, from which all the good timber had been culled, leaving it to inferior kinds with few groups of straggling pines and more valuable hardwoods, without symmetry or system in the distribution of kinds or age classes. At the same time a map was constructed showing ideally how the forest was to look after eighty years' well-planned management. We can then follow in the

* Each state government pursues somewhat different methods of mapping. Sometimes two sets of maps are made, one to show the conditions, which might then be called a timber map, the other to show the working plan; but these are now mostly combined into one.


DISTRICT PINEHILL
DISTRICT OAK GROVE
COXEYTOWN
FORESTVILLE
DANVILLE
SPRING HILL
FOREST MANAGER'S MAP
SHOWING
Pine forest district in the plain, subdivided into compartments, blocks and ranges as is usual in German forestry practice, with age classes in ideal arrangement.
Scale, 1:25000.
reduced to 1:50000.
Legend.
boundaries of compartments
" parcels
" blocks
" range
" district
roads
pine forest
color of age classes
deciduous forest
deciduous trees mixed with pine
pine mixed with deciduous trees
seed beds and nurseries
fellings for the year

maps made every ten or twenty years the changes in appearance under the hand of the forester. During the management new information and experience have dictated modifications of the original working plan, giving rise to a new manager's map; the approach to which appearing in the timber map for 1885 leaves no doubt that at the end of the period of regulation we will have a well-grown pine forest, with deciduous trees mixed in or confined to the more suitable situations, so disposed over the area that annually or periodically the same amount, or nearly so, of valuable material can be harvested.

The painstaking methods of surveying, describing, measuring, calculating, planning, bookkeeping, and repeated revising of all the work from decade to decade were shown in the regulation work of the district Hinternah, Prussia, contained in six large folio volumes of manuscript, continued from the year 1822 to the last revision in 1890. We can only briefly indicate what this work involves, which was briefly summarized in the following exhibit:

FOREST REGULATION.

PROGRESS OF WORK REQUIRED TO BRING FOREST AREAS UNDER RATIONAL FOREST MANAGEMENT.

I. *Geodetic and topographic survey and mapping.*

II. *Forest survey* in connection with I, noting all areas distinguished by quality of soil, composition, and age of timber; general description of forest conditions, of climatic conditions, of surrounding conditions, of possible dangers, of market conditions, means of transportation, etc.

III. *Forest districting.* Division of forest into parcels or lots and aggregation of lots into blocks and ranges. In the plain, rectangular lots, divided by cleared lines called rides (Gestell), are customary; in hilly and mountainous country division lines follow the configuration of soil. Differences of soil or character of growth within lots give rise to formation of sublots.

IV. *Forest yield valuation* (assessment). Ascertaining amounts of timber standing, rate of growth on various sites, determining capability of production and future yield in material and money.

V. *Determining plan of management* (working plans). General plan for all time; special plans for period of ten to twenty years. Determining length of rotation; amounts annually to be cut, designating lots to be cut, with a view to obtaining favorable distribution of age classes; thinnings to be made; methods to be used in felling and cultures.

METHODS OF FOREST REGULATION.

In Prussia it was Frederick the Great who first ordered a regulated administration of the government forests, soon after the beginning of his reign. The first simple prescriptions of dividing the forests into equal areas and cutting every year a proportionate area were followed up with more elaborate ordinances having in view a closer equalization of the amounts of material harvested and revenues obtained, besides other considerations of management for continuity, until finally the basis for present methods of regulation was reached in the ordinance of 1836, since modified in its details, under which "the preservation, revision, and perfection of the work of forest valuation and regulation" is carried on.

The *modus operandi*, similar in principle in all government forest administrations, is about as follows:

Let us assume that the government has purchased* a new forest district, comprising, say, 10,000 acres, the average size of the existing districts. The necessary surveys and blank maps, as explained, have been made and the boundaries carefully established in the field, the

*Prices for forest soil vary, of course, according to their location and condition, just as in our country. In 1849 Bavaria sold 27,000 acres of her state forests at $68 per acre. In Prussia the government has lately (1884–1887) paid prices ranging

division into compartments or parcels, larger or smaller according to the need of a more or less intensive management, have been noted on the maps and marked on the ground (the avenues perhaps partially opened), and for the sake of satisfactory administration a number of the parcels have been combined into subdistricts, "blocks," or ranges; and thus the first—purely geometrical—basis for a rational administration has been established. Now the arithmetical basis is to be ascertained. For this, in the first place, a general description of the district in its present condition is desirable, parts of which, however, can be furnished only after the more thorough measurements described later. Such a description recites all needful knowledge regarding the extent, the manner of division, the boundaries, and the legal rights. Next follows a description in general terms of topography, climate, and soil conditions, and of the forest growth, being a condensation of the special description by parcels. The manner of treatment hitherto, the market conditions, current market prices, and usual wages are noted. Then after recital of the processes and methods by which the information in the following detail work has been obtained, the principles adopted for the management and its motivation are stated, forming a general guide for the manager for all time.

These principles are formulated by a commission, after sufficient general knowledge of the condition of the district is obtained. In this important part of the general description, not only the territorial partition of the district into compartments and blocks or ranges is determined, and reasons given for it, but also the system of management for each block or parts of blocks, whether coppice, standard coppice, timber forest, etc.,* and the length of rotation, i. e., the time within which a block is to be cut over and reproduced; furthermore, the principles according to which the fellings are to progress, reproduction is to be secured, thinnings are to be made, the annual yield to be expected,

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from $5 to $60 per acre, and for a round 70,000 acres the price per acre was $21 average. These were mostly devastated waste lands in the northern plain. In Thuringia, where prices for wood and land are higher, the price for forest land is from $20 to $60 and as high as $80. These prices do not, of course, include any timber growth, the value of which, if present, is calculated according to well-known careful methods of determining "expectation values." According to a calculation by Dr. J. Lehr, based on the net income as representing interest at a 3 per cent rate and assuming a ninety-year rotation of the forest growth for the entire German Empire, the forest land was worth $25 per acre and the wood on it $156 per acre.

*NOTE.—Timber forest (Hochwald; high forest) is a forest in which trees are allowed to grow to maturity and reproduction is effected either by natural seeding from the old growth in various ways or by planting or sowing after removal of the old growth; it is usually managed in rotations of 70 to 120 years.

Coppice (Niederwald; low forest) is a forest in which reproduction is expected by sprouts from the stumps; this is usually managed in rotations of 10 to 40 years.

Standard coppice (Mittelwald; middle forest) is a combination of the two former, the standards being allowed to grow to maturity and reproduction being secured both by seed and sprouting.

Determining the rotation.—Our friends who are attempting to bring about a more rational treatment of our forests have often a mistaken notion as to when timber should be cut, when it is ready for the harvest. This can not be determined by any set period, as in the ripening of fruit in agriculture, or by any more or less defined age, much less by any diameter measure. The determination of the "felling age" (Haubarkeitsalter) or of the length of "rotation" (Umtrieb) depends on the use to which the crop is to be put, the manner in which it is to be reproduced, and the amount of material that can be produced or the amount of profit that can be derived from it. This determination is one of the most difficult, requiring both careful financial calculation and knowledge of forest technique.

The "sylvicultural rotation" is that which considers mainly the forest technique, being the time when perfect natural reproduction is most surely attainable, i. e., fullest seed production in timber forest, highest sprouting capacity in coppice forest; or, when preservation of the productive capacity of the soil, avoidance of damage

and the time within which the forest is to be brought into a regular systematic order of management—in short, all the general framework of the management, as far as determining a set policy into which the special working plans should fit. Before this report can be made final, however, the work of the valuator or examiner must have proceeded to some extent.

VALUATION WORK.

The valuator or estimator upon whose work as a basis the general and special working plans depend, begins by examining and describing briefly the conditions of the soil, its productive capacity, and the kind and appearance of the growth in each compartment (or subparcel, if conditions of growth or soil make such subdivision desirable). In the description the dominating kind of timber or, if mixed in equal proportions, that upon which the management is to be prominently based, is named first and the average age of the growth* with special reference to the dominating timber is ascertained for the purpose of ranging the parcel into an "age-class," which comprises usually twenty years, so that the growth of 1 to 20, 21 to 40, 41 to 60 years, etc., form each an age-class or period. The density of the growth and larger openings devoid of tree growth are specially noted. The valuator at the same time is expected to form, from general appearances, an opinion as to the best treatment of each parcel in the near future, and note it and especially whether the growth is to be cut during an earlier or later period, than its age would warrant considering the likelihood of its thrifty or its unsatisfactory growth. He also estimates the amounts to be taken out in thinnings for the next twenty years.

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from windfalls, diseases, etc., are uppermost considerations. These considerations of course also influence in part the determination of any of the following rotations, which we may call "economic rotations."

The "rotation of greatest material production" is that which allows the forest to grow as long as the average annual accretion is at a maximum. This differs, of course, with species, climate, soil, etc. If for the mass of material we substitute its money value and strive to so arrange that the time of rotation coincides with the largest money returns, we have a "financial rotation."

Various points of view lead to different kinds of financial rotations:

"Rotation of the highest harvest value" or "Technical rotation" which attempts to produce certain desired sizes and qualities in largest quantity with a view of obtaining thereby the largest money return for the crop under the circumstances (management for telegraph poles, fence posts, osier holts, tan-oak coppice).

"Rotation of the highest forest revenue" when the growth is to be harvested at the time of its maximum average annual net money value; this time is influenced both by the amount of material and the price paid for better sizes and quality of wood. In this rotation no regard is paid to the original capital invested in the soil; when this latter factor is introduced into the calculation we arrive at the true "Financial rotation" or "Rotation of the highest soil (or ground) rent," in which the forest is to be cut at a time when the capital invested in soil, stock, and management, furnishes the highest interest rate. This capital as far as the soil is concerned may be represented by its actual cost, or by its market value, or else by its capacity for production (Bodenerwartungswerth; soil-expectation value), which is found by adding the values of expected returns at harvest discounted to the present time and deducting the expenses incurred up to the time of harvest, similarly discounted.

To determine this value, experience tables must give the data. Local conditions and prices and the rate of interest applied of course influence the length of the financial rotation. It is shortest for a firewood management (in Germany say 60 to 70 years), for spruce and pine at an interest rate of 2 to 3 per cent a rotation of 70 to 90 years, with oak 120 years, appear as profitable rotations; where small sizes, mining timber, posts, poles, etc., are bringing good prices, the most profitable financial rotation may be shorter. It stands to reason that the length of this rotation as well as of all others can be only approximately calculated. The forestry literature of Germany is most prolific just now with regard to determining financial rotations, and the highest mathematical skill is employed in the discussion.

*Growth (Bestand;—stand) is here and farther on used in the collective sense of the word to denote an aggregate of trees; for which also the word "stand" may be employed.

With this information established, a table may be constructed, in which the area of each parcel is entered, according to its average age or "age class," modified by considerations of productive capacity and from this a "timber map" is made, showing the present conditions of the forest; the kind of dominating timber in each parcel being denoted by a color, intermixed timbers by signs, and the age by the shade of the color in 4, 5, or 6 gradations according to the number of age classes, as shown in the accompanying ideal map.

ARRANGEMENT OF AGE CLASSES.

Now follows the determination of the future arrangement of age classes, the object of which is to have, when the forest is regulated, in each period of the rotation an approximately equal or equally producing area to be cut. It therefore becomes necessary to shift the distribution of age classes, in order to attain the equality of the sum of areas in each period. In addition to the mere equalization of areas, there are several other considerations guiding the valuator in arranging the age classes. The oldest timber, as well as that which for some reason has ceased to make satisfactory growth, is of course to be cut first; hence the conditions of the areas are more specially examined regarding health, density of cover, soil, vigor, etc. In coniferous growths, especially in the plain, the danger from windfalls, if one parcel is cut and thereby the other exposed to the prevailing storms, necessitates such an arrangement in the location of the fellings (or age classes) that the removal of an old growth will leave behind it a young growth which is less liable to be thrown. This local distribution of the age classes by which, in the direction of the prevailing winds, no two neighboring growths are assigned to the same period is also desirable from other considerations. By avoiding a series of extensive fellings side by side the danger from fires is lessened, and liability to spread of diseases and insect attacks, danger from frost, and drought to young growths, is confined or reduced. Hence an arrangement of the age classes as near as possible after the following scheme has been generally adopted, in which the Roman figures denote the age classes, I standing for the oldest growth, containing, if the rotation has been set at 100 years, timber of 80 to 100 years, to be felled within the first twenty years, II for that to be felled within twenty-one to forty years from the present, and so on, V to be felled in from eighty to one hundred years.

Prevailing winds→

V	III	I	IV
IV	II	V	III
III	I	IV	II
II	V	III	I

FIG. 1.—Diagram showing arrangement of age classes.

In mountainous districts, where the topography influences the expense of transportation, fellings are often more concentrated and the higher parcels used and reproduced before the lower, in order to avoid injury to the young growth by a reversed condition when the

material from above would have to pass through the young growth below. Various minor points may also dictate exceptional arrangement. In coppice growth, needed protection of the stocks against cold north winds makes it desirable to have the fellings progress from the south and west towards north and east. Altogether it will have become apparent that the distribution of successive fellings is an important matter, not only from the standpoint of regulated administration, but also of successful culture.

In the accompanying map (Plate III) we have attempted to give an idea of the matter in which a "manager's map" is constructed, and how ideally in a forest of the plain the arrangement of age classes would appear when the forest regulation is perfected.

Portrait of G. L. Hartig, Oberlandforstmeister of Prussia (1811 to 1836).

This portrait was exhibited to represent the father of the methods of forest regulation in vogue at the present time, as developed in his "Instruction for the valuation of forests," 1795. He was also one of the most fertile writers in forestry literature.

YIELD CALCULATIONS.

When the distribution of areas has been effected in accordance with the considerations set forth, the yield calculations are made. These are computed after careful measurements and by various methods of

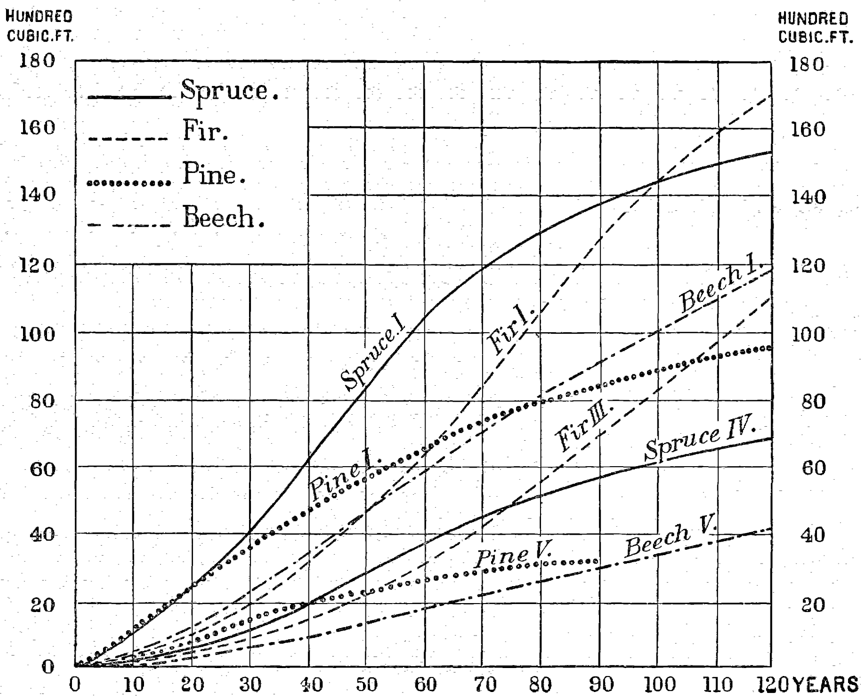


FIG. 2.—Diagram showing comparative progress of yields of spruce, fir, pine, and beach on best and poorest site class.

calculation, which have been developed after much experience during more than one hundred years.

Since the different compartments are cut at different times, not only the present "stock on hand" needs to be measured, but also the accretion for each age class from the present to the middle of the period in which it is to be utilized as to total quantity (decreasing in arithmetical proportion as the stock on hand is diminished by fellings), when by adding the two quantities and dividing the total by the number of years in the rotation or time of regulation the equalized yearly quota to be utilized or "felling budget" (Haubarkeitsertrag or etat) can be calculated.

The determination of existing stock is made by measuring diameter breast high by means of calipers, estimating the average height and calculating contents with the aid of tables which give the corresponding volumes of timber wood (above 3 inches diameter). These tables are constructed after numberless detail measurements from which the "factor of shape" for each species, soil, or climate is derived; for, since the tree is neither a cylinder nor a cone, which could be calculated from the base and height, the modification from either of these two forms, the "factor of shape," must be determined experimentally in order to arrive at the approximately true contents. These measurements are made somewhat like those for which schedules are given on page 310 of this report. In very irregular growths and with skillful valuators a simple estimating of contents or the use of so-called normal yield or "experience tables," which give for the various species, soils, and climates the amount of wood that would normally be produced per acre at a given period, is not excluded.

Normal yield table for spruce.

[Main growth (exclusive of thinnings) per acre.]

Age.	Number of trees.	Cross-section area of all trees breast high.	Average height.	Wood above 3 inches diameter.	Wood, total mass.	Age.	Number of trees.	Cross-section area of all trees breast high.	Average height.	Wood above 3 inches diameter.	Wood, total mass.
Site class I.		*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Site class III.*		*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*
10 years	....	49·2	4·9	86	715	10 years	....	18·3	1·9	....	200
20 years	2,591	114·4	16·7	1,101	2,174	20 years	....	53·7	6·6	100	772
30 years	1,700	159·5	29·2	2,603	4,204	30 years	3,732	86·6	15·7	472	1,617
40 years	1,065	188·4	47·6	4,748	6,378	40 years	2,412	130·1	25·6	1,244	2,760
50 years	724	209·7	62·6	7,222	8,623	50 years	1,580	154·9	36·7	2,574	4,247
60 years	515	225·8	76·7	9,209	10,625	60 years	1,056	171·8	48·2	4,004	5,634
70 years	390	237·1	88·2	10,582	12,198	70 years	724	185·3	59·0	5,219	6,893
80 years	321	244·9	97·4	11,655	13,213	80 years	500	196·2	67·9	6,220	7,994
90 years	269	250·9	105·3	12,555	14,043	90 years	424	205·2	74·1	7,093	8,866
100 years	243	258·4	112·5	13,299	14,715	100 years	380	214·9	79·4	7,922	9,638
110 years	229	264·5	117·7	13,971	15,272	110 years	346	223·2	83·0	8,694	10,296
120 years	226	269·7	121·4	14,586	15,730	120 years	320	230·6	85·6	9,324	10,725
Site class II.						*Site class IV.*					
10 years	....	26·1	3·2	....	415	10 years	....	11·3	1·6	....	157
20 years	....	77·9	11·5	315	1,201	20 years	....	36·5	4·6	....	500
30 years	2,364	89·9	22·6	1,187	2,460	30 years	....	72·2	10·5	140	1,044
40 years	1,619	151·8	35·1	2,502	4,018	40 years	3,164	107·9	18·0	515	1,830
50 years	1,161	180·1	47·2	4,176	5,791	50 years	1,968	130·1	26·2	1,287	2,788
60 years	842	200·1	59·7	6,220	7,851	60 years	1,276	143·5	35·1	2,231	3,761
70 years	639	213·6	71·8	7,808	9,481	70 years	864	154·9	42·6	3,089	4,519
80 years	484	222·7	83·0	9,295	10,725	80 years	648	162·6	51·5	3,790	5,248
90 years	356	231·3	91·5	10,339	11,683	90 years	554	172·3	57·1	4,361	5,763
100 years	301	239·2	97·7	11,125	12,398	100 years	500	181·5	61·3	4,848	6,249
110 years	293	246·5	103·0	11,740	13,013	110 years	464	187·0	63·3	5,305	6,707
120 years	291	252·3	106·6	12,269	13,585	120 years	....	191·4	66·6	5,720	7,150

In very regular growths trial areas only are measured. To indicate this phase of the regulation work there were exhibited of the many instruments in use:

G. Heyers' perfected calipers (best construction).
A. Treffurth's triangular calipers.
Hypsometers (height measurer), construction Faustman, Weise, Wild, Stoetzer.
Accretion borer, construction Pressler, Neuhofer, and Matthes.

These last instruments are most convenient for ascertaining the rate of growth on standing trees, a hollow augur of small diameter (one-fourth inch) taking out of the trunk a core 2 or 3 inches long, which allows the measuring of the width of annual rings, and therefrom, by aid of tables, the calculation of the rate of mass accretion for the past five to ten years, from which a judgment of the probable future accretion can be formed. The more usual manner of determining the rate of accretion, however, for purposes of yield calculation, is by felling sample trees of each class, dissecting and measuring the accretions of past periods, as indicated in schedules on page 310.

In modern times the exact measurements are mostly confined to the growths that are utilized during the first or first two periods of twenty years.

FELLING BUDGET.

After all these data for each compartment have been booked, and the yield of branchwood and roots—for even these are mostly utilized—as well as the probable amounts to be taken out in thinnings, have been estimated and recorded, and after the likelihood of decreased accretion in the different compartments has also been determined from measurements and experience, the "felling budget" is determined as a sum of the stock on hand and the amount of annual accretion multiplied by the time, during which it is allowed to grow, i. e., in the average to the middle of the period in which the compartment is placed, divided by the period of rotation. Thus a growth of eighty-five years, which showed a stock on hand of 3,825 cubic feet per acre, and hence had an average accretion hitherto of $3,825 \div 85 = 45$ cubic feet per year, which is likely to be reduced on account of gradual reduction in stock and other untoward conditions to 30 cubic feet, would yield during the first period $3,825 + 30 \times 10 = 4,125$ cubic feet. And if the compartment contained 50 acres it should be credited in the working plan in the column for the period I with $4,125 \times 50 = 206,250$ cubic feet. By adding up the amounts of the yield of all the compartments placed in the first period and dividing by 20 (the length of the period) the annual budget which should be felled during the period, is found. If, however, it is desired to equalize the fellings more or less through a longer period—for instance, the time of rotation—then the amounts in all the periods must be summed up, and these sums as nearly as possible equalized by shifting the position of the compartments from one period into another (necessitating always new calculations of the accretion) until the equalization in the periodic sums is effected.

Even then, however, before finally determining the annual budget, a calculation is made to see whether the area contains as much timber as it normally should; if more, the budget may be increased; if less, a saving must be made in order to bring up the stock on hand to the normal. If, for instance, we know from the experience tables that our forest should normally yield 50 cubic feet per acre a year in a 100-year rotation, then the normal stock would be $100 \times 50 \div 2 = 2,500$ cubic feet per acre. This is the average amount of wood per acre which we

should strive to keep in stock in order to get the full benefit of the productive capacity of the soil and insure an equal growth and equal annual cut for all time. In reality, this ideal is, of course, never reached, but this so-called normal forest, conceived in ideal condition, serves as a guide in the working plans, and the conception is a most useful and important one. To put it into practice we must either save at first on the annual cut until normal condition is attained, or we may increase the cut if more old timber than necessary for normal stock is on the ground. Additional reserves may also be provided for to avoid any unforeseen shortcomings in the budget due to insect ravages, mistakes in calculations, etc.

We can not here enter into the details of all the work of the valuator, being satisfied by having indicated in general the methods pursued. In coppice management, of course, all these fine calculations become unnecesary, and the periodical or annual cut is determined by area mainly.

From the general plan thus elaborated the special plan for the first period or half period of the management is worked out in detail both for fellings, cultures, and other work, road-building, drainage, etc. This special plan, then, is the basis on which the local manager finally makes out the annual plans of work, which are submitted for revision and approval to the controlling officers. Thus, while the general and special working plans lay down the general principles, the annual plans, into which enter considerations of immediate needs and financial adjustments, permit such deviations from the general plans as may appear needful from year to year. Every ten or twelve years, or at other stated periods, a careful revision of the whole regulation work is made, in which the carefully noted experiences of the manager are utilized to correct and perfect the plans.

In addition to the maps explained before, there were exhibited all

Schedules and instructions used in forest regulation work of Prussia.

The results of such careful administration and the methods in detail, as practiced in Bavaria and Prussia, were exhibited in the following volumes:

The Forest Conditions of Prussia, by O. v. Hagen, 2d edition by K. Donner, now Oberlandforstmeister.

Forest Laws and Executive Orders of Bavaria. Explained by Aug. v. Ganghofer, ministerial councilor; small edition for use of employees.

Forest Survey and Forest Regulation, by Ad. Runnebaum.

The following condensed table was prepared to give at a glance an idea of the profitableness of government forestry in the leading German states:

Forestry statistics of certain German forest administrations showing average cost of administration, gross and net income per acre.

States.	Forest area.	Total expenditure.	Revenue.		Expenditures and revenues per acre of forest.						
					Expenditures.						
			Gross.	Net.	Total.	Per cent of gross income.	Administration and protection.	Marketing crop.	Cultivation.	Roads.	Net revenue.
	Acres.										
Prussia	6,000,000	$8,000,000	$14,000,000	$6,000,000	$1.33	58	$0.48	$0.30	$0.14	$0.06	$0.96
Bavaria	2,300,000	3,150,000	5,880,000	2,730,000	1.37	53	.64	.37	.11	.11	1.19
Würtemburg	470,000	1,025,000	2,260,000	1,235,000	2.17	45	.87	.92	.22	.33	2.63
Saxony	416,000	1,040,000	2,750,000	1,710,500	2.50	37	.65	.81	.11	.21	4.11
Baden	235,000	404,000	1,090,000	686,000	1.54	40	.22	.83	.15	.12	2.90
City of Zürich	2,760	14,000	26,000	12,000	5.00	54	1.14	2.10	.16	1.14	4.40

The average cost of administration is 40 per cent of the gross yield; of this 30 to 40 per cent goes to salaries, 30 to 40 per cent to wood-choppers, 15 to 20 per cent to roads and cultures, 0 to 25 per cent for sundries.

In fourteen state forest administrations, covering 10,000,000 acres, the cut during ten years was 55 cubic feet per acre per year, of which 27 per cent, or about 15 cubic feet, was lumber wood, equal to about 120 feet, B. M.

An idea of the conservative management of the state forests may be gained from the statement that, while in Prussia in the years from 1829 to 1867 the cut increased from 28 to 37 cubic feet per acre and to 46·7 in 1880, the proportion of the old timber over 80 years has during the last twenty years increased from 23 to 27 per cent, the cut in 1880 being 31 cubic feet per capita, valued at 37 cents per cubic foot cut in the forest ready to be hauled.

STATISTICS OF FOREST DISTRIBUTION.

To these statements we may add for convenient reference the following statistics on the forest distribution:

The forests of the German Empire occupy about 35,000,000 acres, or nearly 26 per cent of the total available area, or about three-fourths of an acre per capita of the entire population. In the southern, and more mountainous states it occupies 33 per cent; in the hilly and mountainous districts of middle Germany, including the most densely populated states—Saxony and Hessen—it forms 31 per cent; while in the north German plain it occupies but 24 per cent, and in the seaboard plains but 15 per cent of the entire area. Half the forest is private property in Prussia, Bavaria, and Saxony, besides in some minor states; about one-third is state property in all the more important states except Baden, while in the entire Empire about one-half is private, one-third state, and one-sixth communal property.

In Prussia the state is principal proprietor in the eastern provinces, where state forests occupy 50 to 60 per cent; private or communal ownership prevails in the densely populated western and southern districts, the former (private ownership) far exceeding the latter in most provinces. The communal forests are especially noteworthy, forming as they do often the most valuable resource and relief from taxation. The small town of Goerlitz, in Silesia (62,000 inhabitants), possesses such forest areas of 75,000 acres extent under four managers. As regards the different species, pine predominates in the north and northeast, oak and beech in the west and southwest, spruce, fir, and larch in the south, while the central portion contains them all mixed in varying proportions. The proportionate composition is as follows: Coniferous growth, 65·5 per cent of the total forest area, namely, 42·6 per cent pine, 22·6 per cent spruce and fir, 0·3 per cent larch; deciduous growth, 34·5, of which beech occupies the largest part, namely, 14·7 per cent, oak timber forest 3·5 per cent, while to the standard coppice 6·5 per cent are devoted and the balance to mixed forest and coppice.

METHODS OF HARVESTING AND TRANSPORTATION.

Turning now more directly to the management of the districts in detail, we may begin our survey at the end, as it were, by first glancing at the methods of harvesting and transportation.

As far as practical means and methods in felling and logging oper-

ations go, we can learn but little from Germany, except that more care in the utilization of the timber would be profitable here as it is abroad. Yet it may be of interest, and not entirely devoid of suggestive value, to briefly recite the practices followed in most government forests.

The location of fellings for the year having been determined with due consideration, the rangers engage and control, under supervision of the district manager, the crew of wood-choppers under a foreman, who are mostly men living in the neighborhood of the range or district and accustomed to all kinds of forest work.* A contract, which contains conditions, regulations, and a scale of prices, is made with them, which they sign. The men are paid by the job, the prices per unit differing, of course, in different localities and being graded according to the kinds of timber, size, etc.

To cite one example we may take the schedule prices paid at the city forest of Goslar, as this will interest us further on. There are 40 men nearly permanently employed either in wood-chopping, planting, or otherwise, and their average earnings during three years have been about 80 cents per working day. The prices for cutting spruce, including moving to roads and barking, and the average prices obtained for ten years were as follows:

Cost of cutting.	Average price obtained in the woods.	
	Lowest class.	Highest class.
Sawtimber, above 5 inches in diameter (5 classes) 85 cents per 100 cubic feet	$9.50	$16.20
Long poles (3 classes), from 84 cents to $1.68 per 100 cubic feet	5.90	7.90
Small poles (4 classes), from $1.37 to $3.07 per 100 cubic feet	3.60	5.80
Firewood, split, 70 cents to $1 per cord	3.60	4.30
Firewood, brush, $1.10 per cord	....	1.60

In Prussia the average cost of lumbering (wood-cutting and bringing to roads) for all kinds and dimensions is 65 cents per 100 cubic feet; that is to say, the wood-choppers' bill on the 300,000,000 solid cubic feet of wood harvested annually in the Prussian government forests amounts to $1,950,000. It will appear from the prices for wood cited that often the harvesting is more expensive than the price obtained, as, for instance, for brushwood, which will hardly sell for half the cost of cutting, but its removal is necessary from cultural considerations. The wood-choppers are also sometimes expected to move the cordwood at least to the neighboring roads, so as to obviate the driving of teams through the woods or young growth.

If the felling is to be a clearing, a strip is assigned to each gang of 3 men, 1 with an ax and 2 with saws (felling with the saw, of course, is the rule); if a regeneration cutting or thinning, the trees to be taken are carefully selected by the ranger or manager and marked with a marking hammer. As a rule, all fellings are done during winter, and all trees, except in the coppice and small poles, are felled with the saw close to the ground. In the pineries of the North German plain, where the root wood is salable, they are even dug out and then sawed off close to the root, thus saving a good piece of log timber, which in Saxony increases the wood value of the harvest by fully 3 per cent. Which parts of the log are to be cut into firewood and which into lumber wood or special timbers, and the length of the same according to the

*In the census of Germany for 1881–'82 there were reported as engaged in forestry, hunting and fishing 381,637 persons. Unfortunately, no division of the three occupations was made.

best use that can be made of the stick, are determined by the foreman, or in valuable timber by the ranger or manager himself. A scale of sizes and classes of timber (sortiment) exists: in general, all wood over 3 inches diameter is called Derbholz (coarse wood or lumber wood), all below 3 inches is brushwood (Reisholz), with which root wood (Stockholz) is classed. These last two grades are used as firewood, with which is also classed body wood or split wood (Scheitholz), split from pieces over 6 inches diameter at the small end, and round billet wood (Knüppelholz) of 3 to 6 inches diameter.

The wood to be used in the arts, called timber wood (Nutzholz), may appear either in bolts, corded, or in logs. The diameter measurement of logs is made by the ranger with calipers at the middle of the log. Every cord and every log is numbered and the diameter and length noted on the log, and a list prepared in which the cubic contents are calculated. From this list the manager checks off the result of the felling, marking each piece or cord with the marking hammer, and after advertisement sells at public auction, in the woods or at some public place, the single pieces or cords to the highest bidder over and above the government rate, which for the different grades is established every three years on the basis of, but below, current market prices. The sale of logs is made per cubic foot, and the size of the log influences the rate or price, heavier logs being disproportionately higher in price.

PRICE OF WOOD IN THE FOREST.

During the years 1884–'87 the following prices were obtained by the Prussian forest administration for wood in the forest. This is practically for stumpage, cut and marked, the buyer hauling it from the woods:

Price per 100 cubic feet of wood in Prussia.

Pieces containing 18–36 cubic feet.	Lowest price.	Highest price.	Average price.
Timber:			
Oak	$8.50	$17.30	$12.00–14.00
Beech, ash, elm, maple	5.50	12.25	7.50– 8.50
Spruce	4.75	11.65	7.00– 8.00
Pine	4.75	11.00	6.25– 6.35
Firewood:			
Beech (ash, elm, maple)	.75	1.75	1.00– 1.20
Spruce	.40	1.50	.70– .85
Pine	.45	1.30	.80– .90

To gain an idea of the appreciation of the wood product, without reference to kind, size, and quality, the following series of figures will serve:

Average price per 100 cubic feet of wood realized by the Prussian Government for its entire crop (about 300,000,000 cubic feet).

Years.	Price.
1850	$3.27
1855	3.66
1860	3.69
1865	4.71
1870	4.35
1875	5.21
1880	4.47
1885	4.30
1890	4.40

The highest price for any district was obtained in 1888, being $8.49, while the lowest was $2.82. The lower prices in later years are explained by the large importations of wood, especially from Hungary, Russia, and Sweden; for while our misinformed forestry friends point to Germany as the El Dorado of forestry and proclaim the proportion of forest area there maintained, namely, about 25 per cent, as the ideal and necessary for self support, and, therefore, to be maintained also in this country, they overlook the fact that Germany imports not less than $60,000,000 worth of wood and wood manufactures, mostly of the same kind as grown or manufactured in that country. This represents about 10 per cent of the total consumption of Germany, while the importations of the United States, which imports from Canada alone competing classes of forest products, represent not more than 1 per cent of our probable consumption.

The exports of forest products from Germany, on the other hand, are nearly 50 per cent of her imports and represent mostly manufactures, while in the United States the reverse is the case; that is to say, the United States exports twice as much as it imports, and that mostly raw materials, namely, twice as much in value of raw material as of manufactures.

The countries from which Germany imports raw or partly manufactured wood are mainly Russia, Austria-Hungary, and Sweden, which furnish nearly five sixths of the total importation, while Holland, England, Denmark, Belgium, France, and Switzerland draw about $14,000,000 worth of raw material from Germany.

To protect the forest-owners of Germany, a tariff on importations was imposed in 1885 and increased later. Of the effects of this last measure a government report says that as a financial measure these tariffs have had excellent success, for the revenue from these duties increased from $646,000 in 1880 to $1,732,000 in 1886. But for the forest-owner the hoped-for results did not become apparent; the Austro-Hungarian railroads and shipping interests lowered their rates so as to largely equalize the duty charges. The duties on unmanufactured materials being very low, the lack of results in the market of these is still more noticeable. Yet a salutary effect is stated to be a prevention of still lower prices, and because otherwise there would have been a lack of useful occupation for labor finding remunerative employment in the manufacture of the raw material, which, without the increase in duties, would have been imported in manufactured condition.

PRICE OF MANUFACTURED LUMBER.

The following samples of schedules for manufactured lumber, always delivered at the railroad station, may serve to give an idea to our lumbermen how nearly prices compare with those prevalent in our country. We choose those of eastern provinces, which are in sharpest competition with Russian and Hungarian imports:

Province of Posen.

Timber (7–8·5 inch square):			
Pine	per cubic foot	$0.20 to	$0.22
Spruce	do		.16
Pine (Scotch):			
Plank (2–4 inch), 3 classes	per 1,000 feet, B. M.	27.00	38.00
Plank (1½–1¾ inch), 3 classes	do	26.00	31.00
Flooring (1-inch), 3 classes	do	17.00	22.00
Flooring (1½-inch), 3 classes	do	20.00	26.00
Spruce, rough boards, not edged (4–5 inch)	do		12.00
Spruce (1½-inch), edged, 12–18 feet	do	20.00	22.00

Delivered at Berlin.

Oak (clear), 82 cents per cubic foot, or $68 per 1,000 feet, B. M.
Elm, 78 cents per cubic foot.
Railroad ties—pine, 45 cents; oak, 90–95 cents.

It will be seen that prices for some grades are as high as and higher than in New York. The manager is expected to secure at least the government rate, and has discretion in conducting the sales to the best advantage of the government. Under certain circumstances sales by contract without auctioneering, and, lately, selling on the stump, are permitted.

The transportation from the woods is usually left to the buyer; rarely does the administration float the timber or cordwood out, or carry it to a depot or woodyard to be sold from there, or engage in milling or other operations. On the other hand, it has been recognized during the last twenty-five years that good roads and other ready means of transportation increase the price of the wood disproportionately. A good road system is, therefore, considered the most necessary equipment of the administration, and an extension of permanent and movable logging railroads is one of the directions of modern improvement. This phase of the management was exhibited by the following items:

Models of movable logging roads.
Models of movable loading apparatus.
Set of photographs, showing methods of felling, measuring, and transporting spruce for pulp wood.
Illustrations of a simple logging road and shutes operated in city forest of Zürich.
The Logging Railroads, by Ad. Runnebaum, 1886.
Model of the communal forest of Goslar and surroundings, showing configuration, location of age classes, and perfected road system, with statistics.
Model of macadam and telford road construction.

The interesting, important, and practical features to us in the logging railroads exhibited were their movable character, being divided into sets of pairs of short (2 to 5 yard) rails (12 to 16 pounds per yard) attached to from two to four cross ties, wood or metal, the light sets weighing 75 to 100 pounds (heavy sets up to 166 pounds), so that one workman can readily carry them; the ready connection of sets, one hooking at once into the other without separate mechanism, forming a sufficiently satisfactory joint; the simple "climbing switch," which is applied on top of the track, permitting ready transfer from side track to main track and ready relocation. These roads can be readily laid down without much or any substructure and readily relocated. The cost is shown in the following statement:

For a fully equipped road, 24 to 28 inches width, and 6 miles length, for rails and ties	$9,000
For earthwork, if any, and laying	50 to 500
For rolling stock and apparatus	2,500
	12,000

Or $2,000 per mile at the highest.

Upon a basis of 800,000 cubic feet (about 7,000,000 feet B. M.) to be transported, it is calculated that the cost of transportation by railroad, stone road, and dirt road will be about as 1 : 2 : 6, the cost on the first being about 3 cents per 1,000 feet B. M. per mile as against 18 cents on dirt roads.

Comparing the cost of construction it is stated that the ratio between corduroy, gravel road (13 feet wide), macadam, and movable track is as 1 : 1.25 : 2.35 : 1.17, placing the last among the cheapest.

GOOD ROADS.

A most instructive exhibit in many ways, especially at the present time, since the movement for better roads in this country has begun, was the model of the city forest of Goslar, a small town (13,300 inhabitants) in the Harz Mountains, whose citizens from this piece of property, a spruce forest of 7,368 acres extent, derive not only their pure drinking water, healthful enjoyment in hunting, and refreshing coolness in summer, but also a net income, amounting in round numbers to $25,000 ($3.40 per acre), towards payment of city taxes. This is the result of careful management, which permits an annual cut of 350,000 cubic feet of wood. Of this only 50,000 cubic feet goes into firewood, and 46 per cent, or 160,000 cubic feet, is saw timber, which sells at 10 to 16 cents per cubic foot; while smaller dimensions, poles, etc., sell all the way down to below 4 cents, and firewood at $1.60 for brush to $4.30 for split or round wood per cord. (See page 340 for prices paid to woodchoppers.) Until 1875 the district was without proper roads. By an effort of the competent manager the city fathers were persuaded to locate and build a rational system of roads on which altogether, until 1891, there was spent for building and maintenance about $25,000. The greatest interest attaches to the statistics carefully gathered by the district manager, Mr. Reuss, since it is always difficult to determine the money value of such an expenditure in dollars and cents.

The proper location of the roads is the most important feature. The roads are ranked according to their importance; the width and manner of finish depend on their rank. Main roads are macadamized; roads of third rank, which are used for occasional hauling of wood, are dirt roads.

These statistics were exhibited in a neat table, as follows:

STATISTICS OF ROAD SYSTEM IN FOREST DISTRICT OF CITY OF GOSLAR (HARZ MOUNTAINS, GERMANY).

Properly located, graded, and built roads reduce cost of logging, hauling, and advance the price for wood.

Area, 7,368 acres spruce forest; annual cut, 350,000 cubic feet; road building begun in 1875; total mileage of improved roads in 1891, 141 miles; cost of road system and maintenance until 1891, $25,000.

Cost of logging reduced by good logging roads.

[Daily wages remaining constant at 60 cents.]

Year.	Length of well-built logging roads.	Cost of logging per 100 cubic feet.
	Miles.	
1877	7·5	$1.93
1878	12	1.61
1879	27	1.54
1880	37	1.45
1881	46	1.15
1882	50	1.23
1883	52	1.15
1884	54	1.23

Saving per 100 cubic feet	$0.70
Saving on annual cost of 350,000 cubic feet	2,450.00

Cost of haulage reduced by good wagon roads.

[Price per load remaining constant at $3.60. Full load, before improvement, 85–100 cubic feet; after improvement, 175–250 cubic feet.]

Years.	Cost of haulage per 100 cubic feet.
1871–1877 before road improvements	$1.52
1878–1884	.98
1885–1891	.80

Saving per 100 cubic feet	**$0.72**
Saving on annual cut of 350,000 cubic feet	**2,520**

Price of wood influenced by road improvements.

[Comparison of prices paid at Goslar and at other Harz districts.]

Year.	Length of improved wagon roads.	Prices for wood per 100 cubic feet.		
		At Goslar.	At other Harz districts.	Difference in favor of Goslar.
	Miles.			
1877	22	$8.25	$8.18	$0.07
1878	34	8.65	8.04	.61
1879	42	9.59	8.44	1.15
1880	55	9.79	8.44	1.35
1881	64	9.05	7.78	1.27
1882	68	8.45	7.43	1.02
1883	71	8.65	7.63	1.02
1884	77	10.17	8.18	1.99
1885	78	8.88	8.24	.64
1886	79	9.59	9.39	.20
1887	81	11.12	9.71	1.41
1888	82	11.12	9.98	1.14
1889	83	11.39	10.58	.81
1890	85	11.72	10.92	.82
1891	87	13.13	11.80	1.33
Average for fifteen years		9.91	8.98	.93

Increase in price on total cut of 350,000 cubic feet	**$3,255**
Total profit from improved road system in reduced cost of logging and hauling, and in advance of price received for wood, per annum	**8,225**

Or nearly 33 per cent on investment.

Saving their cost in two years.

Cost of road (marked X on model), macadamized in 1885, $6,960; maintenance for one year, $480; total, $7,440. During 1885–'86 hauling 470,000 cubic feet requiring on old road 4,273 loads of 110 cubic feet average, at $3.60, $15,282.80 (or $2.70 per 1,000 feet B. M.); on improved road, 2,652 loads of 177 cubic feet average, at $3.60, $9,547.20 (or $1.70 per 1,000 feet B. M.), saving of $1 for every 1,000 feet B. M. Total saving in haulage, $5,735.60, or 77 per cent on cost of road in one year.

FOREST PROTECTION.

In this country the greatest danger to the forest, besides the indiscriminate cutting, is to be found in fires. How little this scourge of American forests is known in Germany may appear from the statistics of fires in the government forests of Prussia (representing 60 per cent of the German forest area), 56 per cent of which are coniferous, which show that railroading may be carried on without the necessity of extra risks, if proper precautions are provided. During the years 1882–1891 there had occurred 156 larger conflagrations—96 from negligence, 53 from ill will, 3 from lightning, and only 4 from locomotives. Seven years out of ten are without any record of fire due to this last cause.

From 1884 to 1887 fires occurred in Prussia on 3,100 acres, but only 1,450 were wholly destroyed; i. e., 380 acres per year, or 0.005 per cent of the total area of government forests. In Bavaria during the years 1877–1881 only 0·007 per cent of the forest area was damaged by fire, and the loss represented only 0·02 per cent of the forest revenues. During the unusually hot and dry summer of 1892 only 49 fires, damaging more or less 5,000 acres, occurred.

Besides the thorough police organization and the compartment system, which permits not only ready patrolling but also ready control of any fire, the system of safety strips, described in the report of this division for 1892, where a fuller discussion of this subject may be found, prevents the spread of fire from locomotives.

A much more fruitful cause of damage to the cultivated forests of Germany is found in insect ravages. The annual expenditures in fighting and preventing these in the Prussian government forests in ordinary times, amount to about $50,000. Caterpillars and beetles eat the leaves, and thereby reduce the amount of wood produced and the vitality of the tree; bark beetles follow and kill it; borers of all kinds injure the timber. Hence entomology, the study of life habits of the injurious insects and the methods of checking their increase, forms part of the forester's work. To indicate this branch of forestry there were exhibited:

Injurious insects, bark beetles, pine moths, oak-borers at work and in different stages of development, with their enemies (4 cases).

Set of photographs, showing the development, methods of work, result of the ravages, and methods of fighting the "Nun" (*Psilura monacha*).

This last pest set the forestry world of Germany in consternation two years ago. The most effective method of counteracting its progress was found in the application of "insect lime," a glue made of tarry substances, which is applied in a ring around the trunk, by which the caterpillars are prevented from ascending the tree—the smell seemingly deterring them from crossing—and are readily gathered and killed.

Fungus growth and decay kill the standing tree and injure the cut timber. The study and methods of counteracting this injury form, therefore, part of the work of the forester.

Studies of the decay in oak timber caused by various fungi, specimens and drawings (2 cases).

This exhibit, prepared by the well-known mycologist, Dr. Robert Hartig, one of the most fertile workers and writers on forestry matters, served to indicate this function of the forester.

Series of sections, showing the effects of bad and good pruning.

This exhibited one of the directions in which by proper methods this damage can be avoided.

FOREST CROP PRODUCTION OR SYLVICULTURE.

While we have so far considered mainly the administrative and managerial features of German forestry practice, we come now to the most important and truly technical branch of the art, namely, the forest crop production or forest culture. This part we may call forestry proper, for while the methods of forest regulation, forest utilization, and forest protection, which may be comprised in the one name, "forest economics," are incidental, and may differ even in principle in various countries and conditions, the methods of crop production or forest culture, being based on the natural laws of the interrelations of plants to

soil and climate, must, at least in principle, be alike all over the world. Here pure forestry science finds its application and development.

While the study of soil physics and soil chemistry and the study of climate are accessory sciences to this branch of forestry and must be understood to explain phenomena of tree growth and furnish a basis for the practice, forest biology, which occupies itself with the life history of trees in their individual and aggregate life (consideration of the growing crop), and timber physics, which occupies itself with considerations of the crop after it is grown, in order to establish knowledge upon which the practice can proceed, are the two principal directions in which forestry science works. From forest biology we learn what are the various conditions under which forest trees and forests develop as living beings; from timber physics, we learn what are the results in the wood material of the influence of various conditions. In the practice, then, or art of forestry the knowledge gained from these sciences is applied to attain certain proposed results, to produce a desired crop, which in quantity and quality correspond to the capabilities of soil and climate, and to the art of man in directing the same to best advantage.

Forestry science, like medical science, has until recently been developed mainly by empiric methods; experience has directed the practice rather than knowledge, and only within the last thirty years have exact scientific methods begun to furnish the basis from which general principles applicable everywhere are to be deduced. It was not possible to keep science and practice separated in the exhibit or to cover the important field with any degree of completeness.

The following exhibits served the purpose of bringing to the minds of the beholder the means of artificial afforestation, the methods of natural regeneration, the development of accretion under varying conditions, and especially the study of the influence of light on the same, based upon which is the practice of thinning:

H. v. Cotta, "the father of modern forestry," 1763-1844. Bust and likeness; also photograph of his grave in the woods at Tharandt.

F. W. L. Pfeil, foremost expounder of modern forestry, 1783-1859. Likeness and photograph of the monument in the woods of the Harz Mountains.

Forest planting tools—models of forest plows, subsoil plows, planting dibble, Butlar's planting iron, Wartenberg spade, Solling tree-lifter, wooden transplanting spade, various iron transplanters, Spitzenberg's section spade, screw spade, Hollberg's plant box.

Nursery tools—Hackert's transplanting machine; hand drills, construction Spitzenberg.

Pruning tools—climbing-frame, chain pruning-saw system.

Development of root system of seedlings from seed to 2-year-old plants under varying conditions, 10 sheets from the herbarium of forestry school Giessen.

Album of photographs of groves of American trees grown in Germany for forest purposes.

Sections of American trees grown for forest purposes in Germany.

Accretion rule, system Baur.

Studies in accretion—sections of trees, showing extraordinary accretion; comparative study of the progress of accretion in spruce and fir, from base to top; influence of pruning on accretion of spruce; influence of seed production on accretion of beech; influence of light on accretion, 1 frame and various sections showing the so-called light accretion.

Tree analyses, 1 volume in manuscript; influence of thinnings of varying degree on the accretion of trees, charts and sections taken at different heights; comparative study of the influence of thinnings of varying character in old beech growth, 3 charts and sections.

Tree classes, chart showing comparative height and crown development of trees as basis for selection in thinnings.

v. Seebach method of management in beech forests by underplanting, 2 charts of descriptive matter and 5 tree sections, showing results.

Nördlinger's wood sections for anatomical study.

To every German forester the names of Cotta, Pfeil, and Hartig, are household words, full of meaning as those of the three great men who at the end of the last and beginning of this century, laid the foundation for the modern development of forestry. Hence it seemed appropriate to present some memento and record of their potent influence. All three were prolific writers, and American students of forestry should study their works, which were written at a time when specialization had not yet encumbered the empirical rules of forestry with bewildering detail. Our own conditions at present, as far as forestry is concerned, being not altogether unlike those prevailing at the time when these clear-headed men wrote, their simple manner of expounding the art of forestry may more readily come home to us.

As explained in previous reports and bulletins, the creation of the young forest growth which is to grow into a crop may take place either by means of "artificial reforestation," namely, sowing seed or planting seedlings or cuttings (clearing followed by cultivation), or else by "natural generation," securing reproduction from the seed falling from the old growth, from mother trees left on the ground or from neighboring growths (management in echelons), or by sprouts from the stump.

PLANTING.

Seemingly the simplest and easiest way of reproducing the crop is that practiced in agriculture, namely, removing the entire mature crop and sowing or planting a new crop. But this method, which has been so largely practiced in Europe and admired by our countrymen and writers on forestry, has its great drawbacks, which have of late become more and more apparent, and the tendency now is to return more and more to the "natural reproduction." While the simplicity of the method of clearing and planting recommends itself for a routine or stereotype management, it has not always proved as successful as would be expected. The large clearings which the young planted seedlings are unable to protect from the drying influences of sun and wind bring about a desiccation and deterioration of the forest soil and an enormous increase of insect pests, while other dangers in later life from wind and disease have been largely the result of these uniform growths. And when it is understood that to secure a desirable stand the plantings must be gone over and fail places replanted five, six, and more times, it becomes apparent that the method is extremely expensive, and hence the proper treatment of the natural crop with a view to its reproduction by natural seeding is the most important part of forest culture. Yet under certain conditions, and where no natural crop to manage is found, planting or sowing becomes a necessity and various methods and tools have been developed to meet various conditions.

It would exceed the limits of this report to describe these various methods; we can refer to only one of the simplest and cheapest with which every year many millions of small 1 or 2 year-old pine seedlings are set out in soils which do not need or do not admit of preparation by plow or spade. The instrument used is an iron dibble (Fig. 3); the shoe, with one rounded and one flat side, in shape like a half cone, 8 inches long with 3½-inch base; the handle, a five-eighths-inch rod, 3½ feet long, is screwed into the base of the shoe and carries a wooden crossbar, by which the instrument is handled. The modus operandi is to thrust this iron dibble into the ground; then by moving it lightly back and forth to somewhat enlarge the hole and withdraw it; a boy or girl puts the plantlet in the hole to the flat side, the dibble is thrust again into the

ground 1 to 1½ inch back of the first hole somewhat slantingly towards the bottom, and pressed forward to fasten the plant in its stand, then by irregular thrusts the last made hole is obliterated. Two planters with a boy, carrying the plants in a mixture of loam and water, to keep the roots moist and also heavy for better dropping, may set 5,000 plants in a day.

INTRODUCTION OF EXOTICS—WHITE PINE YIELDS.

The valuable species of trees indigenous to Germany which are subject to special consideration in forest management are but few. The most important forest-forming ones are 1 pine, 1 spruce, 1 fir, 1 larch, 1 oak, 1 beech, 1 alder. In addition we find of broad-leaved trees a blue beach, 1 ash, 3 kinds each of elm, maple, and poplar, in some parts a chestnut, and 2 kinds of birch and linden, and several willows, together

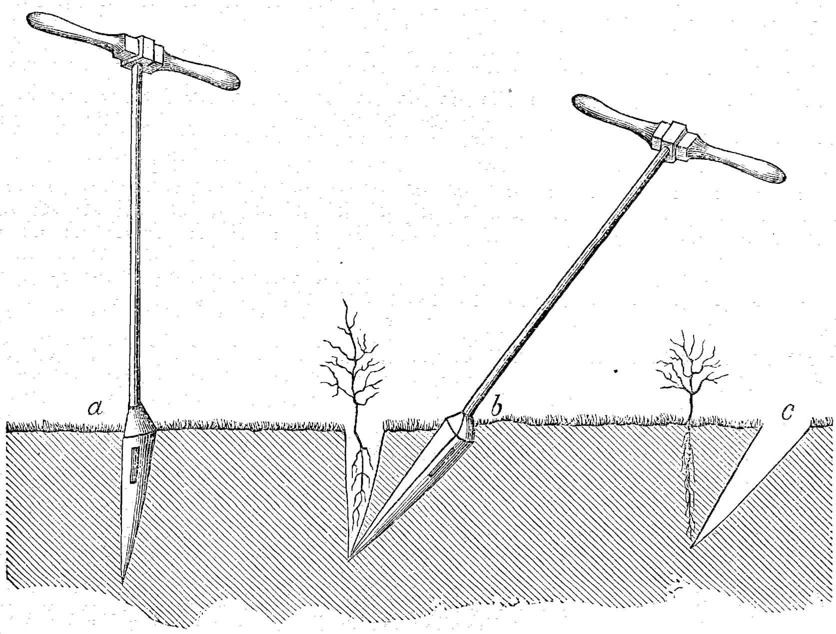


FIG. 3.—Iron dibble used in setting out small pine seedlings.

with some 8 or 10 kinds of minor importance, while of conifers in certain regions 4 other species of pines are found. Some years ago the attention of European foresters was forcibly turned to the richness of the American forest flora, and a movement set in to introduce exotic tree species which might be more productive or show better qualities than the native. Our white pine, a good-sized section of which was exhibited, had been quite extensively planted in the beginning of this century, and these plantations, some 80 or 90 years old, are now coming into use. The quality of the wood, however, has not as yet found much favor, but the quantity per acre exceeds that of any of the native species. Records are extant which show, at 70 years of age, a yield of 14,000 cubic feet of wood containing about 50,000 feet of lumber, B. M., per acre.

On moderately good forest soil in Saxony a stand 78 years old contained over 400 trees per acre, of which three-fourths were white pine,

the rest spruce, larch, beech, and oak. Only 5 white pine trees were under 70 feet high, the majority over 80. Notwithstanding the crowded position, only 45 trees were under 8 inches diameter, the majority over 12 inches, the best 28 inches. The total yield was 12,880 cubic feet of wood per acre, besides the proceeds of previous thinnings. The rate of annual accretion in cubic feet of wood for white pine in the last years amounted to 2·5 per cent of the total contents of the trees, or about 0·4 cubic feet per tree. Of the trunk wood at least 90 per cent could be utilized for lumber, since the shape of these trunks was so nearly cylindrical as to be equal in contents to one-half a perfect cylinder of the height and diameter of the trees taken breast high.

A stand 82 years old on poor land produced 12,500 cubic feet of wood, indicating an average yield for the eighty-two years of 212 cubic feet of wood per annum, of which about 700 feet of lumber B. M. could be calculated. On very poor soil and planted very thick without admixture of hard woods it produced trees 24 feet high and 5 inches thick in twenty years; and on fairly good soil trees 54 feet high, 11½ inches thick, in thirty to thirty-five years, excelling in either case the native spruce (*P. excelsa*) both in height and thickness.

It is also of interest to mention in this connection that a plantation of about 7 acres in the city forest of Frankfort-on-the-Main during the eighteen years ending 1881 brought $115 rent per year for the privilege of seed collecting alone; failing to produce seed only three out of the eighteen years and yielding a maximum of $500 rent during one of the eighteen years; much of the seed finding a market in the United States.

Besides the white pine, the black locust has also for quite a long time found a home in the plantations of Europe, but the species which are now propagated in large quantities, having after trial shown superior advantages in behavior and growth, are our Pacific coast conifers, the Sitka spruce, the Douglas spruce, the Lawsons cypress, and the Port Oxford cedar, sections and photographs of which, grown in Germany, were exhibited, as well as of black walnut and hickory. These trees are now used to plant into fail places or openings, in groups or single individuals, and are especially prized for their soil improving qualities and their rapid growth.

The methods of management for natural reproduction are generally divided into three classes, namely, the coppice, when reproduction is expected from the stumps; the standard coppice, when part of the growth consists of sprouts from the stump, and another part of seedling trees; and the timber or high forest, when trees are grown to maturity and, unless harvested and replanted, reproduction is effected entirely by natural sowing.

COPPICE MANAGEMENT.

This practice is employed for the production of firewood, tan bark, charcoal, and wood of small dimensions, and is mostly applicable only to deciduous trees. The capacity of reproduction from the stump is possessed by different species in different degrees, and depends also on climate and soil; shallow soil produces weaker but more numerous shoots than a deep, rich soil, and a mild climate is most favorable to a continuance of the reproductive power. With most trees this capacity decreases after the period of greatest height-growth; they should therefore be cut before the thirtieth year, in order not to exhaust the stocks too much. The oak coppices for tan bark are managed in a

rotation of from ten to twenty years. Regard to the preservation of reproductivity makes it necessary to avoid cutting during heavy frost, to make a smooth cut without severing the bark from the stem, and to make it as low as possible, thus reducing liability to injuries of the stump and inducing the formation of independent roots by the sprouts.

It will be found often that on poor and shallow soil trees will cease to thrive, their tops dying. In such cases it is a wise policy to cut them down, thus getting new, thrifty shoots, for which the larger root system of the old tree can more readily provide. This practice may also be resorted to in order to get a quick, straight growth, as sprouts grow more rapidly than seedlings, the increased proportion of root to the part above ground giving more favorable conditions of food supply. It must not be forgotten, however, that this advantage has to be compensated somewhere else by a disadvantage; sprouts, though growing fast in their youth, cease to grow in height at a comparatively early period, and for the production of long timber such practice would be detrimental.

Regard to the preservation of favorable soil conditions, which suffer by oft-repeated clearing, requires the planting of new stocks where old ones have failed. Mixed growth, as everywhere, gives the best result. Oaks, walnut, hickory, chestnut, elm, maples, birch, cherry, linden, catalpa, and the locust also, with its root-sprouting habit, can be used for such purpose.

If, when cutting off the sprouts, at the age of from ten to twenty years, some trees are left to grow to larger size, thus combining the coppice with timber forest, a management results which the Germans call "Mittelwald;" and which we may call standard coppice management.

STANDARD COPPICE.

This is the method of management which in our country deserves most attention, especially in the Western prairie States, where the production of firewood and timber of small dimensions is of first importance, though the timber forest, for the production of larger and stronger timbers, should not be neglected. The advantages of this method of management, combining those of the coppice and of the timber forest, are:

(1) A larger yield of wood per acre in a short time.
(2) A better quality of wood.
(3) A production of wood of valuable and various dimensions in the shortest time with hardly any additional cost.
(4) The possibility of giving closer attention to the growth and requirements of single individuals and of each species.
(5) A ready and certain reproduction.
(6) The possibility of collecting or using for reforestation, in addition to the coppice stocks, the seeds of the standards.

The objections to this mode of treatment are the production of branches on the standards when freed from surrounding growth, and the fact that the standards act more or less injuriously on the underwood which they overtop.

The first objection can be overcome to a certain extent by pruning, and the second, by proper selection and adjustment of coppice-wood and standards. The selection of standards—which preferably should be seedlings, as coppice-shoots are more likely to deteriorate in later life—must be not only from such species as by isolation will grow into more useful timber, but, if possible, from those which have thin foliage, thus causing the least injury by their cover to the underwood. The

latter should of course be taken from those kinds that will best endure shade. Oaks, ashes, maples, locust, honey locust, larch, bald cypress, a few birches, and perhaps an occasional aspen, answer well for the standards; the selection for such should naturally be from the best-grown straight trees. The number of standards to be held over for timber depends upon the species and upon the amount of undergrowth which the forester desires to secure. The shadier and the more numerous the standards, the more will the growth of the coppice be suppressed. From a first plantation one would naturally be inclined to reserve and hold over all the well-grown valuable saplings. The coppice is of course treated as described above.

As before mentioned, on account of the free enjoyment of light which the standards have, they not only develop larger diameters but also furnish quicker-grown wood (which in deciduous trees is usually the best) and bear seed earlier, by which the reproduction of the forest from the stump is supplemented and assisted. Any failing plantation of mixed growth, consisting of trees capable of reproduction by coppice, may be recuperated by cutting the larger part back to the stump and reserving only the most promising trees for standards.

If equally well-grown coppice and standards are desired, a regular distribution of the standards, mostly of the light-needing, thin-foliaged kinds, should be made; if prominence is given to the production of useful sizes, the standards may be held over in groups and in regularly distributed specimens, in which case those of the shade-enduring kinds are best in groups.

THE TIMBER FOREST.

In the timber-forest management we may note various methods: The method of selection (Plenterwald), in accordance with which only trees of certain size are cut throughout the whole forest, and the openings are expected to fill up with an after-growth sown by the remaining trees. This method prevailed in former ages, but was finally almost everywhere abandoned because of the difficulty of organized administration and control of such an irregular forest containing trees of all ages, and because the after-growth is apt to progress but slowly with forward-grown trees surrounding and overshadowing it, or may consist of worthless kinds. Of late a revival of this method with various modifications designed to meet the objections is noticeable; the advantage of keeping the soil constantly shaded and thereby preserving the soil moisture also recommending this method. More uniform growths, more regular distribution of age classes, and a more regulated administration was possible by various "regeneration methods," by which a certain area—a compartment—would be taken in hand and the cutting so systematically directed that not only a uniform young growth would spring up through the whole compartment, but by the gradual removal of the mother trees light would be given to the young growth as needed for its best development. This method (Femelschlag) is almost exclusively practiced in the extensive beech forests, somewhat in the following manner:

REGENERATION METHODS.

In the first place it is necessary to know the period at which a full seed year may be expected. This differs according to locality and kind. One or more years before such a seed year is expected the hitherto dense crown cover is broken by a preparatory cutting of the inferior timber, enough being taken out to let in some light, or rather

warm sunshine, which favors a fuller development of seed, the increased circulation of air and light at the same time hastening the decomposition of the leaf-mold and thus forming an acceptable seed bed.

As soon as the seed has dropped to the soil, and perhaps, in the case of acorns and nuts, been covered by allowing pigs to run where it has fallen, a second cutting takes place uniformly over the area to be regenerated, in order that the seeds may have the best chance for germination—air, moisture, and heat to some degree being necessary—and that the seedlings may have a proper enjoyment of light for their best development and yet not be exposed too much to the hot rays of the sun, which, by producing too rapid evaporation and drying up the needful soil moisture, would endanger the tender seedlings. This cutting requires the nicest adjustment, according to the state of the soil, climatic conditions, and the requirements of seedlings of different kinds.

While the beech requires the darkest shade, the pine tribe and the oaks demand more light, and should, by the successive cuttings, be early freed from the shade of the mother trees. Beech seedlings are more tender, and only by the gradual removal (often protracted through many years) of the shelter of the parent trees can they be accustomed to shift for themselves without liability of being killed by frost. The final cutting of the former generation of trees leaves many thousand little seedlings closely covering the soil with a dense shade.

That the method of management must differ according to species and local conditions is evident; and in a mixed forest especially are the best skill and judgment of the forester required to insure favorable conditions for each kind to be reproduced. It is to be expected that such seedlings are rarely satisfactory over the whole area, and that bare places of too large extent must be artificially sown or planted.

Another method is the "management in echelons" (Coulissen, Saumschlag), which consists in making the clearings in strips, and awaiting the seeding of the clearing from the neighboring growth. It is applicable to species with light seeds, which the wind can carry over the area to be seeded, such as larches, firs, spruces, most pines, etc.

The cuttings are made as much as possible in an oblong shape, with the longest side at right angles to the direction of the prevailing winds. The breadth of the clearing, on which occasional reserves of not too spreading crowns may be left, depends of course on the distance to which the wind can easily carry the seed which is to cover the cleared area. Observation and experience will determine the distance. In Germany, for spruce and pine, this has been found to be twice the height of the tree; for larch, five or six times the height; for fir, not more than one shaft's length. From 200 to 360 feet is perhaps the range over which seeding may be thus expected. One year rarely suffices to cover the cleared area with young growth, and it takes longer in proportion to the breadth of the cutting. This method is very much less certain in its forestal results than the next named, and more often requires the helping hand of the planter to fill out bare places left uncovered by the natural seeding. But it is the one that seems to interfere least with our present habits of lumbering, and with it eventually the first elements of forestry may be introduced into lumbering operations.

To be sure, it requires from three to eight times the area usually brought under operation, but instead of going over the whole area every year it may be operated in a number of small camps systematically placed

along a central road connecting the different camps or cuttings with the mill. An ideal arrangement of such management may be sketched thus:

Suppose we have to supply a mill with 2,000,000 feet from pine lands, cutting 8,000 feet an acre, trees which bear seed every two years, and let the period in which full reforestation can be expected be six years. Then a tract of 2,500 acres, or an area of about 3 miles long and $1\frac{1}{4}$ miles broad, must be taken together in operation.

Dividing the tract by a central road on which the mill is situated and making the cuttings 300 feet wide by $1\frac{1}{2}$ miles long, each cutting will contain 54 acres, and about five such cuttings will furnish one year's supply, with an average haulage of less than one mile to mill—twenty-six cuttings will be located on each side of the road.

IMPROVEMENT CUTTINGS AND THINNINGS.

When the area thus treated is covered with the new growing crop, there are in such a growth, of course, more individuals to the acre than can be expected to develop. A struggle for existence soon begins, and a constant natural thinning out is the result, requiring the judicious aid of the forester to produce a desirable termination of the struggle. In this the one point never to be lost sight of is to keep the soil well shaded. In fact, with this one general rule in view, a practical man will usually make but few mistakes in the removal of trees when necessity for it appears, which does not occur until the stems have reached the size of hop poles. Before that time the clearings are mainly to afford protection to the slower-growing and more valuable species by removing or cutting back the quicker-growing and inferior kinds. By no means, however, should the small shrub vegetation ever be disturbed unless spreading over valuable timber growth. So far from injuring the future trees of the forest this undergrowth is a decided benefit, keeping the soil shaded and sheltered against winds and therefore moist, and adding to its richness by the decay of its leaf mold. On the other hand, if of two or more valuable kinds one threatens to overtop the other and to shade it out, the ax may properly do its work in preserving the deserving weaker one. The question, whether a more vigorous clearing out in the earlier stages of development does not favor better development of the remaining growth without injury to soil conditions, is still an open one, though experiments for its solution have been instituted.

Up to a certain point the effect of the struggle between the trees of an even-grown thicket must be considered distinctly useful, by forcing height growth and showing more clearly which are the individuals of weak constitution and therefore not destined to become the dominant growth of the forest. Among this class, which we may call the overshaded, proceeds mainly the work of interlucation, i. e., the periodical thinnings which are made for the purpose of stimulating increased development in the dominant or "forward" trees, by securing to these increased enjoyment of light and room.

How this struggle for life and supremacy, by exclusion from the neighbor of the necessary factor of existence—light—proceeds in a naturally grown forest, is shown in the following interesting table, which was obtained by counting the trees of a naturally grown dense Norway spruce forest at different ages:

Age.	Number of trees per acre.	Over-grown.	Number of dominant growth.	Standing room per tree.
		Per cent.		*Square feet.*
20 years	9,377	49	4,783	4·64
40 years	1,265	42	733	34·43
60 years	604	32	410	72·11
80 years	393	21	310	110·70
100 years	285	11	253	156
120 years	241	4	231	180·75

Such a table is instructive in many ways. It shows that the struggle for dominance is severest in the period from the twentieth to the fortieth year, gradually decreasing with advancing age. From this we may infer that interlucations are most effective in the earlier period. It shows us that those trees which are now dominant, seemingly in full vigor, may yet be overshadowed and at last subdued by their neighbors. Thus we may group the trees of the naturally grown forest into the following classes:

TREE CLASSES: CLASSIFICATION ACCORDING TO CROWN DEVELOPMENT.

AFTER KRAFT.

[Used in determining the degree of thinnings and removals for reproduction.]

Dominant or superior growth.
- *Class 1.*—Predominant trees with highly developed crowns.
- *Class 2.*—Codominant trees with tolerably well developed crowns.
- *Class 3.*—Subdominant trees with normal crowns, but poorly developed and crowded above.

Dominated or inferior growth.
- *Class 4.*—Dominated trees with crowns poorly developed and crowded laterally.
  - (*a*) crowns wedged in laterally, yet not overtopped.
  - (*b*) crowns compressed, partly overtopped.
- *Class 5.*—Suppressed trees, entirely overtopped.
  - (*a*) crowns still having vitality (shade enduring species).
  - (*b*) crowns dying or dead.

An illustration of the appearance of these tree classes will be found on page 364 of this Report.

DEGREES OF THINNING.

The degrees of thinning usually resorted to are the following:

(1) Slight thinning takes out trees of class 5.

(2) Moderate thinning takes out trees of class 5 and 4*b*.

(3) Severe thinning takes out trees of class 5, 4, and sometimes 3.

KIND OF THINNINGS.

Thinnings are usually made for the following purposes:

(1) Improvement cuttings, to improve the composition of the forest and give advantage to the better kinds.

(2) Interlucations, to improve the form and hasten development of young timber.

(3) Regeneration cuttings, to produce favorable conditions for seed formation and reproduction of the forest.

(4) Accretion cuttings, to improve rate of diameter growth in older timber.

Thinnings are to open the crown-cover, giving access to light and air,

their object being to accelerate decomposition of the litter and turn it into available plant food; to improve the form and hasten the development of the remaining growth. The degree of thinning depends on soil, species, and age and is best determined as a proportion between the present growth and that which is to remain with reference either to crown-cover, mass, or diameter.

By thinnings or interlucations we imitate, assist, anticipate nature in this process of elimination, and, according to the degree of our thinning, we speak of a light or, as the Germans call it, "dark" interlucation, which removes only the suppressed, dead, and dying stems; a moderate one, which takes all the overgrown; and a severe one, which attacks also the lowest grades of the forward-grown, and even interrupts somewhat the upper crown cover. The degree of interlucation to be practiced depends greatly on the soil and the exposure; a "dark" interlucation is in most cases sufficient.

The necessity of a severer interlucation presents itself in a growth with an unusually large number of trees of uniform caliber, where sometimes the struggle for supremacy is unduly prolonged and the lessening of overstock is needed to secure the development of larger dimensions. Predominant trees ought to be taken only exceptionally, when a more valuable kind, which we want to favor—as, for instance, white oak—is in danger of being overwhelmed by a less valuable overgrowing neighbor, or when, on account of some peculiarities of a foregrown species of tree, detrimental consequences must be anticipated.

A deep, rich soil, with abundant moisture, on northern and northwestern exposures, will endure a severe interlucation with least injury, because the vigorous growth due to its favorable conditions will soonest close any gaps. On the other hand, it will almost always be well to leave even suppressed trees on thin and dry soils and those exposed places where by their removal entrance would be given to drying winds and sun.

The degree of thinning depends also a great deal on the species forming the forest. In another place we have pointed out the importance of the classification of the different species with reference to their relation to light and shade, as shade-enduring and light-needing. This classification has some bearing on the degree of interlucation. Those kinds which require for their development a larger amount of light would naturally show in a dense growth a greater proportion of suppressed trees, and consequently a severer interlucation would be indicated. On the other hand, these very species are the least capable of preserving favorable soil-conditions, because their naturally thin foliage not only does little toward the increase of the layer of humus, but does not efficiently exclude the rays of the sun, especially as they have the tendency with increasing age to thin out still more in their leafage. They are, therefore, the most difficult to manage, and the continuity of their crowns must be most carefully preserved.

The time when the first thinning should take place is generally determined by the possibility of marketing the extracted material at a price which will cover at least the expense of the operation. This is, however, not always possible, and the consideration of the increase in value of the remaining growth, or rather of the detriment to the same by omission of timely thinning, may then be conclusive.

On good soil and on mild exposures interlucation may take place earliest, because here the growth is rankest and a difference in the development of the different stems is soonest noticeable. Light-needing and quicker-growing kinds show similar conditions to those grown on

good soil, and here, therefore, early thinnings are desirable. In these cases the thinnings have also to be repeated oftenest, especially during the period of prevalent height accretion. Absolute rules as to the time for interlucations and their periodical repetition evidently can not be given. The peculiar conditions of each individual case alone can determine this. The golden rule, however, is, early, often, moderately. The right time for the beginning of these regular and periodical interlucations is generally considered to have arrived when the natural thinning out before mentioned commences and shows the need of the operation. This occurs generally when the crop has attained the size of hop poles At this stage the well-marked difference in size of the suppressed trees will point them out as having to fall, and there will not be much risk of making any gross mistakes. Until the trees have attained their full height the thinning should remain moderate. From this time forward it will prove expedient to open out the stock more freely, without ever going so far as to thin severely. Within the last few years new and revolutionary ideas regarding principles and methods to prevail in thinnings are gaining ground, which we have not space here to discuss.

UNDER-PLANTING.

All these manipulations experience modifications according to circumstances, different species and soil conditions requiring different treatment. One of the most interesting modifications, the results of which in a given district were fully exhibited, is the v. Seebach management in beech forests. Such a management, which contemplates the production of heavier timber in the shortest time, tries to take advantage of the increase in accretion due to an increase of light which is secured by severe thinning; and in order to prevent the drying out of the soil by such severe thinning a cover of some shady kind is established by sowing or planting. This cover gradually dies off under the shade of the old timber, the crowns closing again after a number of years. The rate of growth in a stand of 70 to 80 years was thereby increased from 51 cubic feet per acre and year to 77 cubic feet per acre and year, while a neighboring stand, otherwise the same, but not so treated, increased by only 60 cubic feet, distributed over a larger number of trees.

The same method is applied to the production of heavy oak timber. In this case the oak growth is thinned out when about 60 years old and "underplanted" with beech. It may also be applied to older growths with advantage, as appears from the following results:

A stand of oaks 150 to 160 years old in 1846 was thinned to 96 trees per acre, averaging 37 cubic feet of wood per tree, the cleared space being "underplanted" with beech and spruce. In 1887 the oaks, now 190 to 200 years old, of which 59 trees only were left, contained 56 cubic feet in the average, thus growing during the last forty years more than one-half as much as during the one hundred and fifty to one hundred and sixty years previous to the operation, i. e. doubling the rate of growth. In this case, under the light-foliaged oaks, some of the beech and spruce developed sufficiently to furnish marketable material.

With Scotch pine it has been found in one case that while the average accretion of a stand 120 years old under ordinary condition was about 59 cubic feet per acre and year—the yield by thinning included—a stand underplanted with beech showed an accretion of 160 cubic feet per acre and year, besides much better log sizes and earlier supply of saw timber.

Translated into money an example from Bavaria may be cited as follows:

On one acre of pine 80 years old, underplanted at a cost of $2.85 per acre with beech now 40 years old, there were found—

	Yield of wood.	Average annual accretion per acre.
	Cubic ft.	*Cubic ft.*
105 pines	322	40
2, 300 beech	156	39
Total	478	79

Supposing this stand to be left forty years longer, it may be figured that the pine would bring $650 and the beech $120; total per acre, $770, of which $49 was yielded in thinnings. White pine without undergrowing is expected to produce only $520 per acre when 120 years old.

As a basis for the management of thinnings and the highest effect of the same upon the increase in the mass of trees and the material product, intimate studies have been made into the influences of various conditions upon the accretion of trees and forests, results of which were shown in charts and sections.

Simply to indicate the necessity for the forester to study the anatomy and quality of the wood material, a study collection of thin sections for examination with the magnifying glass, prepared by the father of timber physics, Dr. H. Nördlinger, was also shown.

FORESTRY EDUCATION AND FORESTRY LITERATURE.

To be sure, the highly elaborate system of forest administration and forest management here outlined could not be developed or maintained without a special high-grade education of those who direct the work. This education is provided for in the most ample manner, and consists not only in theoretical studies at schools, academies, and universities, but also in practical studies in the forest itself under the guidance of competent and experienced forest managers.

The course which applicants for positions in the higher administrative forestry service are expected to follow, with more or less modification in the different states, may be briefly outlined here:

After promotion from college the student goes into the woods for a short period (one-half to one year) to acquaint himself, under the guidance of a district manager, with the general features of the business he proposes to engage in, and thereby tests his probable fitness for it. He then visits for two and one-half or three years a forestry school (called academy when by itself, when at a university it is connected with the "faculty" for national economy), where theoretical studies with demonstrations in the forest are pursued.

After examination and promotion the applicant is bound at his own expense to occupy himself for two years at least in studying the practice in various districts, changing from place to place. If occupation can be found for him he is employed at small daily wages on some scientific or administrative work, always keeping an official diary of his doings and observations, certified to by the district manager with whom he stays, and which forms part of his final examination. For nine months during this time he must continuously perform all the duties of a lower official—a ranger—for a whole or part of a range, and some-

times also for a given time certain functions of a district manager. Then, after two years of law studies at a university, he enters into a close and difficult examination for a position as district manager, lasting eight to ten days. By passing this he is placed on the list of eligibles, and has thereby secured a right, enforcible in the courts if need be, to a position when a vacancy arises and his name is reached in the order of the list. This, in Prussia, may now be within eight or ten years after listing. During the interval he may be, and mostly is, employed on daily wages in various sorts of scientific and administrative work, such as revising and making new valuations, laying out roads, acting as tutor at the academies, or as assistant to district managers, or else taking the place of a manager temporarily, etc.

The higher administrative offices are filled by selections from the managers, length of service counting only when special fitness for the kind of work required accompanies it; so that, as in the army, the highest officer has been through all the grades below and is conversant with every detail of the service. The pay is small, graded in each kind of position according to length of service and somewhat according to cost of living in different places. The honor of the position, to which usually other honors are added, its permanency, and the assurance of a pension, graded according to length of service, in case of disability or age, make up for small salaries. The salaries, subject to change from time to time, without adding the value of perquisites like houses, farm lands, etc., range about as follows in Prussia:

1	director (Oberlandforstmeister)		$3,600
4	forest councilors (Landforstmeister)	$1,800 to	2,400
33	chief inspectors (Oberforstmeister), (with additions for house and traveling up to $1,100)	1,050	1,500
89	inspectors (Forstmeister) (with additions for house and traveling up to $1,100)	900	1,500
679	district managers (Oberfoerster), (with additions up to $825 and house and field)	500	900
3,390	rangers (Foerster) (with house and addition up to $110)	260	360
349	guards (Waldwaerter)	100	200

The rangers (Foerster) follow different courses of instruction, part of which they receive in subordinate positions under district managers; while serving in the army in special battalions (chasseurs) they receive also theoretical instruction, which is supplemented in special schools. When finally promoted to the responsible position of rangers, in which much discretion and latitude are given them, their pay amounts to from $260 to $360, with a house and field, with the assurance of pension on withdrawal.

It was the privilege of the writer to visit nearly every higher forestry school in Germany, as well as that at Zürich, Switzerland, and to secure some material which should aid in completing the exhibit and bring the existence and work of the institution to the attention of our public.

In addition to materials contributed, which have been mentioned before, the following served more specially the latter purpose:

Eberswalde: Water-color painting commemorating the 50-year jubilee of the institution in 1880; portrait of the director, Dr. Dankelman; photographs of the academy building, old and new; samples of work of students in manuscript (4 volumes); catalogues, plans of instruction, etc.; literature of professors.

Münden: Photographs of building and surroundings; map of city forest; guide and map to surrounding forests, used for instruction.

Tharandt: Photographs of buildings and surroundings; portrait of the director, Dr. Fr. Judeich; plan of instruction; map of surrounding forests, used for instruction.

Eisenach: Photographs of surroundings; photographs of professors; map of Thuringian Mountains; three German eagles, pair of mountain cocks (Auerhahn and Birkhahn).
Tübingen: Map and guide to the surrounding forests, used for instruction; literature of professors.
Giessen: Guide to experimental garden.
Munich: Literature by professors.
Zürich: A comprehensive collection of various materials specially prepared by Dr. Anton Buhler, the competent occupant of the chair of Foresty, and director of the Forest Experiment Station, especially charts illustrating experiments in thinning and forest meteorological observations; description of methods of reforesting denuded mountain slopes; plans of forest-garden experiments, etc. There were also exhibited by various plans and photographs methods and results of the model forest administration of the city forest of Zürich under the competent manager, Forstmeister Meister.

This opportunity was also used to form an opinion as to which of the 8 institutions visited would serve best the purpose of giving American students of forestry that knowledge which they can acquire only in a country where forestry has been practiced and object lessons are to be had, and where the principles underlying forest-crop production or forest culture have been fully developed.

While every one of the institutions has some special points to recommend it, be it due to its location or to the personnel of its faculty or to its methods of organization, I have come to the conclusion that all points of advantage in the institutions considered, together with the objects and nature of students from the United States, the choice should be between Munich and Zürich, or part of the time at each, with a short visit to either Eisenach, Tharandt, Münden, or Eberswalde.

The following table gives information regarding these forestry schools:

Higher forestry schools in Germany for the education of forest managers.

[Austria and Switzerland included.]

Name of place.	State.	When founded.	Length of course (years).	Instructors of forestry branches proper.	Total number of instructors.	Average attendance of forestry students.
At universities:						
Giessen	Hesse	1825	3	3	(*)	40-50
Tübingen	Wurtemberg	1818	(†)	3	(*)	50-60
Munich	Bavaria	1878	(†)	8	*18	90-100
At polytechnicum:						
Karlsruhe	Baden	1832	3	2	19	15-30
Zürich	Switzerland	1855	3	3	*20	15-30
Vienna	Austria	1875	3	6	43	130-140
Separate academies:						
Aschaffenburg	Bavaria	1807	2	2	9	90-100
Tharandt	Saxony	1811	2½	3	10	100-135
Eisenach	Saxe Weimar	1830	2	3	8	65-75
Eberswalde	Prussia	1831	2½	6	14	140-150
Münden	...do	1868	2½	5	13	40-60

*The entire corps of professors of the university. In Munich 18 professors are engaged in lecturing on subjects which concern forestry students; in Zürich, 20 professors. In Munich all studies can be followed in any year, as the students may select. The attendance varies, of course, widely in different years, having been as high as 216 in Eberswalde and 120 in Münden. The above figures are for 1885-'86.

† Not prescribed.

The following table will serve to give an idea of what instruction is to be had at these institutions:

Plan of studies at Forest Academy Eberswalde.

Subjects of instruction.	Whole number of hours.
FUNDAMENTAL SCIENCES.	
Natural sciences.	
General and theoretic chemistry	32
Special inorganic and organic chemistry applied	80
Physics and meteorology	80
Mineralogy and geognosy	60
Definition of minerals and rocks	20
Reviews for organic natural sciences	16
Botany in general and forest botany in particular	64
Anatomy of plants, vegetable physiology and pathology	60
Microscopy	20
Botanical reviews	20
Botanical excursions, each 2½ hours	80
General zoology	16
Vertebrates	80
Invertebrates, with special reference to forest insects	80
Zoölogical preparations	16
Zoölogical reviews	20
Zoölogical excursions, each 3 hours	96
Total natural sciences	840
Mathematics.	
Geodesy	72
Interest and rent account	20
Wood-measuring	20
Mathematical reviews and exercises	56
Surveying and leveling exercises, each 4 hours	192
Plan-drawing exercises, 2½ hours	80
Total mathematics	440
Economic sciences.	
Public economy and finances	48
Total sum of hours for fundamental sciences	1, 328
PRINCIPAL SCIENCES.	
Cultivation of forests	80
Forest implements	20
Geographical forest botany	48
Protection of forests	32
Forest usufruct and technology	80
Forest surveying	20
Appraising forests	80
Calculation of the value of forests and forest statistics	32
Administration of forest and hunting	48
Redemption of rights of usage	32
Forest history	40
Forest statistics	20
Review of various forest matters	56
Examinations	40
Forest excursions, each 4 hours	352
Total	980
SECONDARY SCIENCES.	
Jurisprudence.	
Civil law	72
Criminal law	32
Civil and criminal law suits and constitutional rights	40
Jurisprudence	36
Total	180
Construction of roads	32
Hunting	32
Shooting exercises, 2 hours each	96
Total sum of hours for secondary sciences	340
Grand total	2, 648

	Per cent.
Fundamental sciences	50
Principal sciences	37
Secondary sciences	13

Average per instruction week (21 weeks in winter, 17 during summer; 2 winter courses, 3 summer courses):

$$\frac{2648}{93} = 28{\cdot}5 \text{ hours, or per day, } 4{\cdot}9 \text{ hours.}$$

LITERATURE.

In addition to the live teachings, which an able corps of professors impart at these institutions and that which competent managers are ready to impart to the young students in the forest itself, a large number of weekly, monthly, quarterly, and annual journals and publications are keeping the foresters and forestry students *au courant* with the progress of forestry science and forestry technique. Adding the publications of this nature which appear in Austria and Switzerland in the German language, and which have their constituency in Germany as well, we can make the following respectable list, not counting the journals of the lumber trade and other related publications. Those

marked with an asterisk (*) are to be found in the library of the Division of Forestry; those marked (†) are considered the best or are most comprehensive; those marked (?) have been discontinued.

German forestry periodicals.

Name of publication.	Published at—	Issued—	Established.
Allgemeine Forst-u. Jagdzeitung * †	Frankfurt-on-the-Main	Monthly	1824
Aus dem Walde	Hanover	Irregularly	1865
Aus dem Walde	Frankfurt on-the-Main	Weekly	(?)
Deutsche Forst-u. Jagdzeitung	do	Semi monthly	(?)
Forstliche Blaetter	Berlin	Monthly	1863
Forstlich-naturwissenschaftliche Zeitschrift *†	Munich	do	1892
Forstwissenschaftliches Centralblatt * †	Berlin	do	1856
Jahresbericht des schlesischen Forstvereins	Breslau	Annually	1841
Jahresbericht der preussischen F. u. J. Gesetzbegung.	Berlin	do	1868
Land-u. Forst-wirthschaftliche Zeitschrift	Vienna	Quarterly	1886
Muendener forstliche Hefte *	Berlin	Irregularly	1892
Oesterreichische Forst zeitung *	Vienna	Weekly	1882
Der praktische Forstwirt fuer die Schweiz	Davos	(?)	(?)
Schweizer Zeitschrift fuer Forstwesen	Zürich	Quarterly	(?)
Tharandter forstliches Jahrbuch*	Dresden	Annually	1850
Verhandlungen der Forstvereine	Various	do	
Bericht ueber die Versammlung deutscher Forstmaenner.	do	do	
Zeitschrift fuer Forst-u. Jagdwesen * †	Berlin	Monthly	1869
Zentralblatt fuer das gesammte Forstwesen * †	Vienna	do	1875
Zeitschrift der deutschen Forstbeamten	(?)	(?)	(?)

Should the reader wish to collect a library of the most modern thought on all or any subject pertaining to forestry in Germany the list of books found at the Exposition should satisfy him, for although the books exhibited do not by any means include even all the best or most comprehensive or needful literature, they leave no subject untouched.

Publications of Professors at the University of Munich and of other authors.

[Faculty of Political Economy and Forestry.]

Author.	No.	Subject.
Prof. Dr. Karl Gayer	1	Sylviculture.
	2	Forest Utilization.
	3	The Mixed Forest.
Prof. Dr. F. V. Baur	4	Wood Measuring.
	5	Geodesy.
	6	Investigations into Actual Mass and Weight of Cordwood and Bark.
	7	The Spruce; Its yield, Accretion and Shape.
	8	The Beech; Its Yield, Accretion and Shape.
	9	Yield-tables of Spruce.
	10	Forest Valuation.
	11	Damage Awards to be Given in Forest Cessions.
	12	Academy or University?
	13	Forstliches Centralblatt (Forestry Journal).
	14	Forest Experiment Stations.
Prof. Dr. R. Weber	15	Forest Regulation.
Prof. Dr. H. Mayr	16	The Forests of North America.
	17	From the Forests of Japan.
	18	Monograph on the Abietineæ of Japan.
Prof. Dr. R. Hartig	19	The Decay of Wood.
	20	Investigation into Growth and Yield of Beech, Spruce, Pine, Fir, etc.
	21	Profitableness of Management for Timber in Spruce, and of Management for Firewood in Beech.
	22	Important Diseases of Forest Trees.
	23	Diseases of Trees.
	24	Investigations from the Forest Botanical Institute.
	25	The Wood of Conifers.
	26	The Wood of Beech (Hartig and Weber).

Publications of Professors at the University of Munich—Continued.

Author.	No.	Subject.
Prof. Dr. R. Hartig	27	Anatomical Distinction of Woods.
	28	The True Rot (Merulio lacrimans).
	29	Anatomy and Physiology of Plants.
Dr. K. v. Tubeuf	30	Contributions toward Knowledge of Diseases of Trees.
	31	Seeds, Fruits, and Seedlings of Forest Trees.
	32	Forest Natural History Journal.
	33	Seedlings of Abietineæ.
	34	Curcubitaria Laburni.
	35	Formation of Heart in Trees.
	36	Annual Botanical Reports.
Dr. Aug. Pauly	37	Bark Beetle Studies.
Dr. E. Ebermayer	38	Hygienic Significance of Forests.
	39	Physics of the Soil.
	40	Composition and Value of Forest Litter.
	41	Physiological Chemistry of Plants.
	42	Physical Effects of Forests.
	43	Properties of Forest Air.
	44	Lightning and Hail in the State Forests of Bavaria.
Drs. J. Lehr and T. Lorey	45	Allgemeine Forst u. Jagdzeitung (Forestry Journal).
Dr. T. Lorey	46	Handbook of the Entire Knowledge of Forestry.
Dr. H. Fuerst	47	Forestry Dictionary.
Dr. F. Judeich	48	Tharandter Forestry Annual (Journal).

FORESTRY ASSOCIATIONS.

Forestry associations thrive better in Germany than in the United States and are of a different character; they are associations of foresters, who practice what they preach. There is no more need of a propaganda for forestry than there would be here for agriculture, and the discussions, therefore, are moving in technical, scientific, and economic directions. Besides some thirty or forty larger and smaller local associations there is held every year a forestry congress, at which the leading foresters discuss important questions of the day.

FOREST EXPERIMENT STATIONS.

In addition to all these means of education and of advancement of forestry science, there has been developed in the last twenty years a new and most important factor in the shape of forest experiment stations, which are mostly connected with the forestry schools. If forestry had a strong and well-supported constituency before, this additional force has imparted new impulses in every direction.

The first incentive for the establishment of these stations came from the recognition that the study of forest influences upon climate could be carried on only with the aid of long-continued observations at certain stations. Accordingly, during the years 1862 to 1867, forest meteorological stations were instituted in Bavaria, which, under the efficient direction of the well-known and eminent Dr. Ebermayer, for the first time attempted to solve these and other climatic questions on a scientific basis. The results of these and other observations have been fully discussed in Bulletin 7 of this division, published during this year.

We were privileged to exhibit some of the apparatus devised by Dr. Ebermayer, and some of his results, namely:

Set of soil thermometers,
Rain gauge combined with evaporimeter,
Two charts showing relation of rainfall and evaporation within and without forests.

While these stations were continued and others added in all parts of the country, an enlargement of the programme was soon discussed with great vigor, leading (between the years 1870–'76) to the institution of fully organized experiment stations in Prussia, Bavaria, Saxony, Thuringia, Wurtemberg, Baden; Switzerland and Austria following in the same direction; all of these finally combining into an "association of German forest experiment stations," similar to the association of agricultural experiment stations in our country. Thus the science of forestry, which hitherto had been developed empirically, has been placed upon the basis of exact scientific investigation, the fruit of which is just beginning to ripen in many branches.

We, in the United States, are fortunate in that we can learn from the experience and profit from the assiduous work of these careful investigators. While we may never adopt the admirable administrative methods that fit the economic, social, and political conditions of Germany, we shall ever follow them where the recognition and utilization of natural laws lead to the practical acknowledgment of general principles and to desired economic results in forest culture.

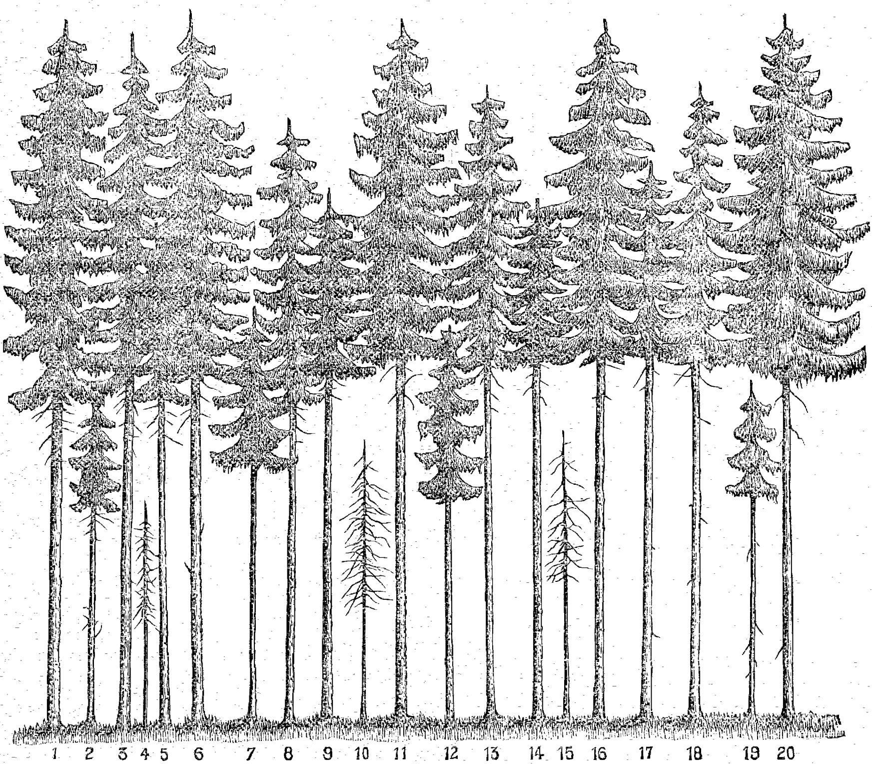


FIG. 4.—Tree classes: Classification according to crown development. Schematic (see p. 355). Class 1 (predominant): Nos. 1, 3, 6, 11, 16, 20; class 2 (codominant): Nos. 8, 13, 18; class 3 (subdominant): Nos. 9, 14, 17; class 4 (oppressed): Nos. 5, 7, 12; class 5 (suppressed, *a*): Nos. 2, 19; class 5 (suppressed, *b*): Nos. 4, 10, 15.

REPORT OF THE SUPERINTENDENT OF GARDENS AND GROUNDS.

SIR: I have the honor to submit the following report for the year 1893 on matters pertaining to the objects and operations of this division.

Very respectfully,

WILLIAM SAUNDERS,
Superintendent.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE YEAR.

The work of maintaining, with ordinary care, the structures and grounds of the Department has been duly performed. The propagation of various economic plants for distribution has been assiduously prosecuted, and many thousands of healthy young plants have been produced and sent into localities suited to their growth. The work of overhauling glass structures is continued, also of repairing woodwork, and reglazing roofs where defective. Much of this repairing remains to be done.

NOTES ON MISCELLANEOUS PLANTS.

The following notes on miscellaneous plants have been prepared for the information of correspondents, and in answer to repeated inquiries by different individuals on the same subjects. These inquiries are submitted to this division, and the answers are directly practical in their nature and applicable to all who desire suggestions for practical purposes.

WILLOWS.

The willow family is one of the most extensive among trees. Under this species, their general economic characteristics may be noted. A few species of special importance will be further mentioned.

Willow timber is light, smooth, soft, extremely tough, and not easily splintered. It is used in shipbuilding, for making ball bats, floats of water wheels, and handles for various agricultural tools, for which its lightness renders it very well fitted. When sawn into boards it is well adapted for lining carts and wagons, as it stands great concussion and pressure without fracture. It is also used for brakes for wagons and railway carriages, as it does not readily ignite by friction. When kept dry it is lasting, roof rafters of the wood having remained sound for a century.

Its charcoal is esteemed for the manufacture of powder, and for crayons for sketching and drawing. The young shoots are used for plaiting. Willow bark has a feebly aromatic odor, and a peculiar bitter astringent taste. It yields its active properties to water, with which it forms a reddish-brown decoction which has been found beneficial as an external application to ulcers and old sores. An alkaloid called salicin has been obtained from it in the form of grayish crystals, and has been employed as a substitute for quinine in intermittent fever. The bark and leaves are used for tanning leather, and in Norway and Lapland green willow shoots and leaves are collected, dried, and stored for the use of cattle.

In Egypt a medicinal water, called Calaf, is distilled from willow blossoms; it is used to promote perspiration, and is cooling and cordial.

The white willow (*Salix alba*) is a native of Europe, from Norway to the Mediterranean Sea and Northern Asia. It is always very plentiful throughout various parts of the United States, having been long introduced. It grows to a height of 50 or 70 feet, and sometimes higher in favorable situations. The white willow is a very rapid-growing tree, and on this account is well adapted for forest planting as a shelter and "nurse" to hard-wooded, slow-growing, but more permanently valuable trees. Even on poor soils it will grow well where most other trees will make poor progress. It is sometimes called the Huntingdon willow.

The common osier (*Salix viminalis*) is a slender branched tree, a native of Europe, where it is very extensively cultivated for basket-making. There are several varieties of this species, all of which yield tough and pliant shoots well fitted for weaving and making hoops; it is one of the best basket willows in this country.

The red osier (*Salix rubra*), a native of Northern Europe, is highly esteemed for its tough shoots for basket work. When well grown the shoots are from 7 to 10 feet long, and of proportionate thickness; therefore it is much cultivated for the manufacture of crates, heavy baskets, and for barrel hoops.

Salix purpurea is a species frequently employed in Great Britain for making fences, the shoots and leaves being so bitter that rabbits and other animals will not eat them. It is one of the most popular kinds for basket work, its shoot being long, clean, and pliable when grown for this purpose. In rich damp soils it will produce shoots 10 feet in length, but it is not well adapted to boggy lands which are constantly wet. It is sometimes called the whipcord or swallowtail willow.

The species *Salix triandra* is of low growth and is considered one of the best for basket-making. Its rods are very white when peeled, and they can be split up very finely, so as to be used in the finer kinds of basket and wickerwork. Many of the willows which are esteemed in Europe for their pliant, smooth, and clean-splitting shoots are found not to be so well adapted to the warmer and drier climates of the United States. The young growths are frequently checked about midsummer and become partially ripened; then a rainy period follows, and the shoots branch out into many small side twigs which render them comparatively worthless for weaving purposes. This species (as also the preceding one) proves to be well adapted to our climates. It succeeds well on wet low lands; also in rich dry uplands. It ripens its shoots to the extreme points, and is therefore very hardy and not liable to be winter-killed in northern localities.

The British species *Salix forbyana* is considered one of the best for the finer kind of willow manufacture. The stems grow erect, are slender,

very flexible, and tough; they grow from 5 to 7 feet in length, and are covered with a grayish-yellow bark. The rods of this willow do not whiten well when peeled, but it is highly esteemed for purposes for which unpeeled rods are used. This willow adapts itself well to warm climates.

The goat willow, or sallow (*Salix caprea*), is a native of Europe, where it is esteemed as a rapid-growing tree, and frequently attains a height of 40 or 50 feet. The wood is white, tough, and smooth in grain. The flowering branches are very ornamental, and are gathered in some places, as is palm, for the decoration of churches. Its hardness and rapid growth combine to make it of much value as a shelter tree for exposed situations; it is also esteemed above most willows for the amount and value of its timber.

The Bedford willow (*Salix russelliana*) is a native of Great Britain, where it frequently reaches to a height of 70 or 80 feet. The wood produced by this species is said to be the most valuable of any of the willow family. The bark contains a large amount of tannin, and is said to yield a larger quantity of the principle, salicin, than any other of the species. It has a European reputation as a valuable basket willow, but it is branchy and somewhat brittle when grown in some parts of this country.

In cultivating willows for the manufacture of the various articles called willow ware, it is generally presumed that they will succeed on wet lands where no other plant will grow. They survive in very wet places, but they can not be grown profitably on lands constantly saturated with water. Low meadows, where the soil is deep and moist, but where saturation is obviated by surface or underground drainage, are best adapted to willow culture. The ground should be prepared by plowing, harrowing, and replowing, in order to secure a deeply loosened stratum in which to easily insert the cuttings, which are usually made from shoots of the growth of the previous year; these are cut in lengths of from 10 to 12 inches and inserted in a slanting position and deep enough to be entirely covered with the soil. The usual method is to set the cuttings 2 or 3 feet apart, in rows which are 4 feet distant from each other, and allow the shoots to proceed from stools or stumpy stocks above the surface. The spaces between the plants are plowed so that the surface soil is kept loosened and clear of weedy vegetation until the stools occupy the whole surface, which they soon will by the annual removal of the shoots, and then further culture is abandoned. Another method, which is considered preferable, is to set the cuttings 12 inches apart in rows which are 3 feet distant from each other; the cutting is pressed down so that the top bud will be at least one inch beneath the surface; in all subsequent removals of the young willows they are cut very closely down, at or even below the surface, so that no external stumps or stools are formed. Following this method the ground can be plowed annually after the crop is gathered, and the whole field afterwards well harrowed with a blunt-toothed harrow, so as to not tear or split the plants. By this culture the soil can be cleaned effectually at little cost, and the thorough culture will add to the vigor of the plants. Manure can also be readily applied, as the tops of the plants are so low that hauling wagons over the field does not injure them. It is further claimed that by this method the shoots grow straight upward from the ground. When grown from high stumps a small portion of the lower end of the willow rod is bent or crooked, which impairs its value to that extent.

The crop can be harvested at any time after the leaves fall. Some-

times cutting is delayed until the buds are about to start in spring, which is the best time for peeling, and the bark then separates easily from the wood; but the plants are greatly weakened when the cutting takes place at so late a period. The preferable time to cut is in December, when the willows are tied in bundles, which are set up on end in 6 or 8 inches of water, where they are kept during winter and until they begin to grow in spring, when the bark becomes sufficiently loose to be easily peeled off.

When it is intended to remove the bark by steaming or boiling, the willow bundles are set up anywhere until they are dry enough to be placed in stacks or stored in covered sheds until wanted. Willows peeled after the sap has started in spring are of a fine white color, while those which undergo steaming or the boiling process for the removal of the bark are of a dark buff color, owing to their being stained by the coloring matter in the bark, which is dissolved and imparted to the wood by the heating process; but it is found that articles made of boiled willows are much more durable than those made from the white rods of spring peeling.

ACACIAS.

Acacia catechu.—A low-growing tree of the East Indies, which has been introduced and cultivated in various tropical regions for the sake of its wood, from which is prepared the highly astringent substance called catechu, or cutch, and sometimes *Terra japonica*, a name it received when first introduced as a medicine in Europe, from the supposition that it was an earth and that it came from Japan. Immediately beneath the brown bark of the stem there is a layer of very white wood next to the heartwood, which is of a dark red or nearly black color, from which the cutch is procured. To obtain the catechu or cutch, the tree is cut down and the exterior layer of white wood is removed; the heartwood is cut into chips and boiled in water until it attains considerable consistency, when, by further boiling and evaporating the water, the thickish extract is spread on mats to dry; before becoming quite hard it is divided into square blocks, and the small squares are turned over frequently until they harden to a condition fit for packing. As it appears in commerce, catechu is a dry, brown, somewhat resinous-looking pulverulent substance, breaking with a dull fracture, dissolving almost entirely in water, and having a strong astringent taste. Its principal use is for tanning purposes. Mixed with oil, like paint, it is used in India to prevent the ravages of wood-eating ants. It is used as an astringent in medicine, and in India a famous ointment for sores and ulcers is made, by reducing to a fine powder and mixing with oil 4 ounces of catechu, 1 ounce of alum, and half an ounce of white resin. The wood of the tree is considered to be more durable than teakwood. It is doubtful if this plant can be grown with any profit in the United States.

Acacia farnesiana.—A low tree or large shrub, very widely distributed throughout tropical and semitropical climates. It is very extensively cultivated in some parts of Southern Europe for its globular heads of flowers, commonly called cassie flowers, and which yield the perfume so named. This perfume is obtained by maceration, a process employed for extracting the fragrance of flowers which can bear a tolerable degree of heat without losing their scent. A certain quantity of grease is placed in a pan fitted with a water bath, where it is heated until it is brought to an oily consistency. Flowers of the cassie are

then thrown in and left to digest for some hours, after which they are removed and fresh ones put in—an operation which is repeated for several days, until the grease becomes saturated with the odor. It is then taken out and pressed in cloth bags. This plant is found growing in various portions of the Southern States, and could be utilized for the manufacture of perfumery.

Acacia arabica.—This species is a native of Arabia and Southern Asia, and yields a portion of the brown-colored gum arabic of commerce. Several species of acacia yield this gum in common. It is obtained from them by spontaneous exudation from the trunk and branches, or by incisions made in the bark, whence it flows in a liquid state, but soon hardens by exposure to the air. The largest flow is yielded during the hottest part of the season. A wet winter and a cool summer are said to be unfavorable to the supply of the gum. It is very nutritious, and the natives almost live upon it during the time they are employed in collecting it for market. The bark, known as babool bark, is strongly astringent, and is used for tanning. On the upper Nile the tree is known as the sunt, and it is said to be the only wood that the soil of Soudan supplies capable of being sawn into planks. These planks, which do not exceed 10 feet in length, are joined together in layers to the thickness of a foot, and are thus employed for ship-building; they are so arranged that they overlap each other, and in this manner a vessel is built without ribs or other internal support. It is supposed that the wood of this tree is the shittimwood of the Bible, although some authorities assign it to other species of acacia. This species has been distributed to some extent in the Southern States, in some of which it is likely to succeed, although no reports have been received as to its adaptability to climates here.

Acacia decurrens.—This is an Australian tree of medium size, the bark of which is highly esteemed for tanning. It contains from 20 to 30 per cent of tannin, according to the age of the tree, which also yields a gum similar to gum arabic. The bark is said to improve by age, and yields about 40 per cent of a kind of catechu, about half of which is tannic acid. A small quantity of bichromate of potash added to the boiling solution of the tannin produces a ruby-red dye. Black dyes are also produced with iron oxides in the solution. It is called the black wattle tree.

Acacia pycnantha.—This is a rapid-growing Australian tree, called the golden wattle. This and other *Acacias* are called wattle trees, because their flexible twigs are used in Australia for weaving into fences. The bark of the golden wattle tree contains about 25 per cent of tannin, and the boiled infusion yields a cutch of much value, which is used to some extent in smearing ropes and fishing nets, to protect them from decay by exposure to water. This and the preceding species are noted as producing a large amount of tanning bark, of the richest kind. Seeds of these have been distributed in Texas and other States. If they are found to succeed, it would probably result in the introduction of a profitable industry.

ALOES.

Aloe vulgaris, Aloe spicata, and Aloe socotrina.—The aloes are plants which usually have short stems, and thick fleshy leaves; they are very generally diffused in all warm countries, and produce the drug known as aloes.

The most esteemed aloes of commerce is that furnished by *Aloe socotrina*, a native of the island of Socotra, on the south coast of Arabia, in the Indian Ocean. This appears in commerce in pieces having a yellowish or reddish-brown color; occasionally it appears of a lighter color, but becomes darker by exposure to the air. The color of its powder is a golden yellow; it has a peculiar, not unpleasant, odor, and a bitter, disagreeable taste, with an aromatic flavor. Socotrine aloes is held in high esteem. Hepatic aloes is considered to be an inferior selection from the Socotrina. Barbadoes aloes is produced in the West Indies from *Aloes vulgaris*, a widely diffused species, extending to Arabia and the African coast. The color of this article is generally dark brown, or black, but sometimes it is of a reddish-brown or liver color, or of some intermediate shade. It has a dull fracture, and the powder is of a dull olive-yellow color. It is made by expressing the juice from the leaves, or chopping them and then evaporating their decoction until it has attained such a consistence that it will harden in cooling, when it is poured into vessels and allowed to concrete. Barbadoes aloes is in great demand in veterinary practice.

Cape aloes is the product of *Aloe spicata* and is received from the Cape of Good Hope. It is sometimes called shining aloes. When freshly broken it has a very dark-olive or greenish color approaching to black. Its odor is strong and disagreeable. When hard it is very brittle and easily powdered, but in very hot weather it becomes soft and tenacious.

The quality of the drug depends much upon the method of preparing it. The finest kind is obtained by exudation and subsequent inspissation in the sun. The plan of bruising and expressing the leaves, and boiling down the juice, yields an inferior article, as a large portion of the liquor is derived from the mucilaginous juice of the parenchyma. The worst plan is said to be that of boiling the leaves in water and evaporating the decoction. The odor of aloes is different in the different varieties. They are all intensely bitter. The active principle is a bitter extractive called aloin. It is powerfully cathartic. The bitter resinous juice from which the drug is prepared is stored up in vessels lying beneath the skin of the leaves. The juice is collected by cutting off the leaves close to the stem and placing them at once into tubs in an upright position, so that the sap may flow freely from the cut surface. If the leaves are very large a longitudinal incision is made from top to bottom to facilitate the discharge. The crude juice is then exposed to the sun, where it is gradually evaporated to a proper consistence and is then poured into vessels, where it hardens into a black, compact mass. Much of the value of the article depends upon the care bestowed upon its preparation for market. Horse aloes is a very coarse article made from refuse leaves, and is used in veterinary medicine. The cultivation of the aloes in Barbadoes is very similar to the cultivation of cabbages in our own market gardens, with this difference, however, that the aloe will retain its vitality for many weeks, even if left on the surface of the ground exposed to the sun. In Africa they cover what would otherwise be sterile, arid plains. It is presumed that these plants could be grown in Florida, and perhaps in other States, especially *Aloe spicata*, which is said to be the hardiest of the group.

CASHEW NUT.

The cashew nut (*Anacardium occidentale*) is a tropical tree cultivated in the West Indies and other countries for the sake of the nuts, the kernels of which are edible, and used for various purposes. The fruits

are somewhat kidney-shaped, containing between the outer skin and the kernel a layer of pulpy matter highly charged with an exceedingly caustic oil, which causes severe blisters on the lips and tongue if an attempt is made to break the shell with the teeth. This causticity is destroyed by roasting, which has to be done cautiously, as the acrid fumes will destroy sight and produce inflammation if the smoke touches the face. The kernels are then sweet and agreeable, and are sometimes ground up with cacao in making chocolate. The kernels are sometimes broken up and mixed with Madeira wine, which is thought by some persons to improve its flavor. The fruit, or apple, which is a thickened receptacle from the end of which the seed of the nut obtrudes, has an agreeable subacid flavor, slightly astringent; the juice expressed, and fermented, yields a wine, and, when distilled, produces a spirit which is used as rum. A gum-like substance is also exuded from the tree, similar to gum arabic, but having an astringency repellent to insects when applied to flooring, book covers, etc., particularly in tropical countries, where insects of the ant species are abundant and destructive. The oil extracted from the kernel is sweet tasted, and equal as an edible oil to that of the olive or almond. This is altogether distinct from the oil alluded to as furnished by the acrid outer skin or covering.

In the East Indies the nuts are used as a table fruit. The acrid oil has been used with success as an application to allay cancers, ulcers, corns, etc., but requires great caution in its use. The plant is very ornamental, and the flowers exceedingly fragrant; it is occasionally found in hothouses, but is impatient of water, and requires high temperature to keep it in health. Many calls have been made for plants of this species, and some have been supplied to residents of southern Florida; but no reports have been received regarding them, and it is very doubtful if they will grow at all in this country.

BOX TREE.

The box tree, or boxwood tree (*Buxus sempervirens*), is an evergreen plant seldom reaching over 20 feet in height, a native of various parts of Europe and Asia. There are several varieties which are often cultivated for ornament, and a very dwarf kind is commonly employed for planting in continuous lines for the purpose of defining the edges of borders and walks in gardens. The wood of the box tree has long been celebrated for its hardness and closeness of grain. The mediæval collections testify to the exquisite skill of some of the old wood carvers on this material. Its chief characteristics are excessive hardness, great weight, evenness and closeness of grain, light color, and its susceptibility to a fine polish. These are the qualities which render it so valuable to the wood-engraver, the turner, the mathematical-instrument maker, and others. The best is said to come from the vicinity of the Black Sea, and this formerly appeared in commerce in logs 4 feet long and from 6 to 9 inches in diameter.

In the district of Tenckaboun, in the province of Mazenderum, Persia, the boxwood grows in abundance. In 1876 purchases to the value of $140,000 were made of this wood in that province, but as it is being rapidly cut and no provision made for planting more, the supply will soon be exhausted. For engravers' use the wood is cut across the grain into slices about an inch thick. The roots are used for inlaying and for fine cabinet work. The ancients made great use of the box in the ornamentation of their villas, and made musical instruments from its

wood. Pliny says that nothing is more fit to be clipped into shapes, and that no animal will touch its seeds; the branches are fatal to camels that eat them, and Corsican honey was supposed to owe its notoriously bad qualities to the bees feeding on the flowers of the box tree. Although slow of growth, it is quite likely that the planting of this tree for the sake of its wood would ultimately prove a profitable investment. The world's supply is rapidly becoming exhausted, and its place, as far as known at present, can not be supplied by any other wood. The plant readily adapts itself to any climate, except extremes of either heat or cold, although a zero cold does not affect it.

CÆSALPINIAS.

Cæsalpinia coriaria.—This is a native of the West Indies, Mexico, and Northern Brazil. It forms a spreading tree from 20 to 30 feet in height. It produces racemes of white flowers, which are followed by curiously twisted, flattened pods about 2 inches long and about 1 inch in breadth, and curved like the letter S. The pods contain about 50 per cent of tannin, and, in combination with valinia, are much employed by tanners. They are known in commerce under the names of divi-divi and libi-dibi.

Cæsalpinia echinata.—This species produces the Brazil wood of commerce, used for dyeing purposes, its color being changed by the use of different mordants from yellow to red, or rose color, but it is not very lasting. The most permanent colors are those in which the natural purple red is changed by acids to an orange or yellow color. Only the heartwood of the tree is used. It is very hard, and is used in turner work and for violin bows. The dye is an ingredient in red ink. Brazil wood boiled in water becomes darker in color as the water becomes red. Paper tinged with the decoction is altered to a violet color by action of alkalies and to a yellow by most of the acids. The action of sulphuric-acid gas renders it white. Paper tinged with this dye will be changed to a yellowish color if dipped in vinegar in which sulphuric acid is present, even if only one two-hundredth part of this acid is present in the vinegar. The woods known in commerce as Lima, peach wood, Pernambuco, and Nicaragua are supposed to be identical with this species.

Cæsalpinia sappan.—This is a native of the East Indies and furnishes the sappan-wood of commerce. The hard wood of this tree yields a bright fugitive red dye, and although not so rich in coloring matter as Brazil wood it is brighter and more delicately beautiful. It is cultivated by the Hindoos for dyeing the straw used in making mats and is used for dyeing silks of a dark-red color. The root affords an orange yellow dye. The Indian name for sappan-wood is bukkum or wukkum. These plants furnish a large amount of tanning material. They have been tried in Florida, where they grow slowly, but endure the climate of the southern portion; they do not promise to become of any material value.

PIGEON PEA.

Cajanus indicus.—This is an East Indian plant, cultivated in many tropical regions for the sake of its seeds, which are largely used as food in various parts of the world. The plant is of a shrubby habit and is sometimes grown in greenhouses for its showy yellow flowers. In the East Indies it is called the Dhal, and the Congo pea. In Jamaica it is known as the pigeon pea. A variety called the No-eye pea produces

seeds as delicate as many of the common garden peas. They are boiled and eaten in the green state; also dried and split for use. Pea meal is prepared from the dried seeds and is said to be of excellent quality. Horses and cattle feed upon the young shoots, and fodder made of the dried leaves and young branches is used for feeding animals. It has been cultivated in this country, but has not proved of sufficient value to become popular where so many superior varieties of peas are in cultivation.

PAPAW TREE.

Carica papaya.—This is a small tree, rising from 20 to 25 feet in height, with a slender stem surmounted by a cluster of large leaves on long foot stalks. The carica is a native of South America, but widely dispersed in the West and East Indies, southern Florida, etc., and is generally known as the papaw tree. The fruits are produced at the base of the foot stalks of the leaves, generally in whorls round the stem; they are from 6 to 8 inches long, of oblong shape, resembling a melon, and are sometimes called melon apples. When ripe the fruit is greatly esteemed by the natives in some parts, being eaten either sweetened with sugar or flavored with pepper, to take away the strong acrid taste which prevails owing to the presence of a milky juice. The immature fruits, when pickled, closely resemble mangoes. The milky juice from the unripe fruits is used medicinally, as are also the powdered seeds, each being considered a powerful vermifuge. The leaves have the power of creating a lather, and in some places are used as a substitute for soap. A peculiar property of the papaw tree is its alleged influence in rendering meat tender. It is said that the juice of the tree causes a separation of the muscular fibers. By some it is maintained that this effect is secured merely by suspending the meat beneath the foliage of the tree during the night; others place greater reliance in wrapping the meat in the leaves for a few hours with a portion of the young fruit. When the juice of the papaw is treated with water the greater part dissolves, but there remains a substance insoluble which has a greasy appearance; it softens in the air and becomes viscid, brown, and semi-transparent. When thrown on burning coals it melts, and drops of grease exude which emit the noise of meat roasting, and it produces a smoke which has the odor of fat volatilized and leaves behind no residue. The substance is fibrine, which is rarely found in vegetables.

THE CLOVE TREE.

The clove tree (*Caryophyllus aromaticus*) is an evergreen, attaining a height of from 20 to 30 feet. It is a native of the Molucca Islands, but has been introduced and cultivated very generally throughout the East and West Indies. Its flowers are of a purple color, produced in great abundance in short terminal panicles of from 12 to 18 in each bunch. The cloves of commerce are the unopened flower buds. These are collected before they expand by beating the flower panicles with reeds, and are received on sheets spread for the purpose. Sometimes they are picked from the tree by hand when they can be easily reached. The cloves are prepared for commerce by smoking them brown over a slow wood fire and finally drying them fully in the sun. The quality of the clove is greatly influenced by climate, and although largely produced in other parts, those from the Moluccas are held in the highest esteem. The trees are planted in rows about 16 feet apart and the field kept clean and well cultivated. The plant is very frequently grown in green-

houses, but will produce flowers only where a sufficiently warm temperature is maintained.

Cloves when good are dark, heavy, and strongly fragrant, the ball on the top being unbroken and yielding oil when pressed by the finger nail. Cloves contain from 17 to 22 per cent of essential oil, which is extremely pungent, and specifically heavier than water. When they are newly gathered a certain quantity of oil may be obtained by pressure; the cloves are thereby much impaired in value, but are often mixed with sound samples, where they can be detected by their pale color, shriveled appearance, and lack of flavor. They are sometimes adulterated with water, which they absorb to a large extent, and thus give a fictitious value when sold by weight. Cloves are the most stimulating of the spices, and are much employed in cookery and as condiments in pickles and preserves. The oil is a popular remedy for toothache and is used as a carminative in medicine. This plant is very frequently called for by Florida cultivators, but to all inquiries the statement is made that the clove plant can not become of commercial value in that State on account of the climate being too cold for it during a portion of the year.

CAROB BEANS.

Ceratonia siliqua.—This is a tree growing from 30 to 40 feet in height, is a native of the countries bordering on the Mediterranean Sea, and cultivated to a very considerable extent for the sake of its pods, which contain a fleshy pulp surrounding the seeds. They are known as carob beans, which come from the generic name of Algaroba, used in various countries to designate pods, pronounced *kharoub* by the Arabs. These pods contain a quantity of agreeably-flavored mucilaginous and saccharine matter, although not very nutritious. They form a prominent ingredient in various cattle foods of trade. The exports of these pods from Cyprus amount to 10,000 tons yearly. They are also known as locust pods, or St. John's bread, from a supposition that they formed the food of St. John in the wilderness.

A kind of brandy is prepared from the carob bean, which is sometimes flavored with juniper berries and passed as a substitute for gin. The Department has, from time to time, propagated and distributed many hundreds of carob plants, chiefly in Texas, and less plentifully in some of the Southern States, but no returns have been received in regard to the outcome of these distributions.

OTAHEITE GOOSEBERRY.

The large shrub, or small tree, *Cicca disticha*, a native of India, is cultivated in many parts under the name of Otaheite gooseberry. The fruits are green and resemble those of the gooseberry; they are acid and used for preserving or pickling, and eaten either in a raw state or cooked in a variety of ways. A decoction of the leaves is used to cause perspiration, and the roots have violent emetic properties. It grows in some parts of Florida and is worthy of cultivation, both on account of the fruits and the beauty of the plant.

QUINOA.

Chenopodium quinoa is an annual plant, indigenous to Mexico and South America, and long cultivated at great elevations on the slopes of the Andes, in Chile and Peru, where, owing to the height and cold-

ness of the locality, neither wheat nor barley can be grown. The seeds resemble those of millet, and contain 40 per cent of minute starch granules, upwards of 5 per cent of sugar, 7½ per cent of casein, and 11 per cent of albumen. They are prepared for food by boiling in water, like rice, forming a kind of gruel or broth, which is seasoned with Chile pepper and other condiments. The seeds contain a bitter principle, which renders the preparation rather unpalatable, and which is only partially removed by cooking. It is said that there are varieties in which this bitterness is much modified. They are considered to be very nutritious and an excellent winter food for poultry. Seeds of the above were disseminated some years ago, but failed to attain popularity.

CHICK-PEA.

This plant, *Cicer arietinum*, is widely known throughout the world as the chick-pea. It is a low-growing branching annual, a native of the south of Europe, but cultivated to a considerable extent both in Africa and Asia. In India the peas are known as gram, and are esteemed as an article of food, being ground into meal and baked into cakes. The peas do not become soft in boiling, and are more frequently roasted or parched. In this state they are used by travelers. The plant has been cultivated since a very remote period by the Egyptians, Hebrews, and Greeks. The dewdrops that form on the leaves are peculiarly acid. This dew is collected and preserved in bottles, being used with water in cases of indigestion. It becomes more acid the longer it is kept. The roasted seeds are used as coffee.

CLUSIAS.

Clusia flava.—This is a native of Jamaica, also found at Key West, in Florida. It is a small tree, seldom exceeding 20 feet in height. It is mostly parasitic on the stems and branches of other trees. This habit of growth is supposed to be occasioned by birds accidentally scattering the viscid seeds, which take root on the bark of trees upon which they happen to be deposited. The roots creep along the surface of the stem in quest of nourishment and support, penetrating into any decayed cavity, and finally reaching the ground (although they may start 40 feet from it), when it soon becomes an independent tree. A viscid, tenacious, resinous juice, which is at first of a whitish color, but becomes red or brownish when exposed to the air, exudes from every part of the plant. It is used as a dressing for sores on horses; it is also employed for stopping leaks in boats.

A Brazilian species (*Clusia insignis*) has flowers which give off a considerable quantity of resin from the disk and stamens, so much so that an ounce has been obtained from two flowers. This resin, rubbed down with the butter of the chocolate nut, is employed to alleviate the pain of sore breasts.

Clusia galactodendron.—This plant is said to be one of the palo de vaca or cow trees of South America. The bark is thick, covered with rough tubercles, and its internal tissue becomes red when exposed to the air. The milk is extracted by making incisions through the bark to the wood. One tree is said to yield a quart in an hour. The use of this milk is accompanied by a sensation of astringency in the lips and palate, which is said to be characteristic of all edible vegetable milks. This species can be grown only in warm countries.

COLA NUT.

Cola acuminata is a medium-sized African tree, the seeds of which, under the name of cola or guro nuts, have from time immemorial occupied a prominent place in the dietetic economy of the native tribes of that country. Within the last few centuries, however, their use has been more extensively diffused, and the demand for them has established a large commercial industry between the regions of Central Africa, whence the principal supply is obtained, and the coast districts of that country, as also to other tropical countries where they are in demand. The cola tree is now widely diffused. It was introduced into Jamaica about the year 1630, its importation being ascribed to the urgent request of an agent of large sugar estates on that island for the benefit of the Gold Coast negroes working these sugar plantations, and in all countries where the negroes were imported and located in large numbers the importation of the tree was a necessary consequence, where it was cultivated for their special advantage and benefit. Thus it was introduced into the Mauritius, the West India Islands, Brazil, and other regions in South America.

The practice of eating cola is supposed to be very ancient. A small piece of the nut is chewed before meals as a promotor of digestion and to improve the flavor of anything eaten after it. Lopez, an early Portuguese adventurer, writing of the subject, states: "The negroes hold the nuts in their mouths, and chew, or at least eat, them for quenching their thirst and better relishing of their drinking water; they comfort and preserve the stomach, but, above all other virtues, they are singularly good against diseases of the liver."

There are but few books of travels or discoveries in Western or Central Africa which do not contain some reference to or description of the popular appliances of these nuts and the great estimation in which they are held.

Although for a long time the cola nut was known to be famous, yet, until a comparatively recent period, nothing was definitely ascertained as to the botanical history of the plant that produced it, or the nature or character of the properties which it contained. Chemistry, however, has revealed that the nuts contain theine, an active principle found in other vegetable products used as beverages throughout the world. They further contain a small quantity of a fragrant aromatic volatile oil, a large quantity of starch, and some fatty matter. The fresh nuts are bitter and astringent; this is lost in drying, as the dry nuts have no trace of bitterness, and are supposed to be less active than when fresh and moist. Among the European population in Africa the cola nut is beneficially used in cases of diarrhea, and the natives attribute to the fresh nuts similar remedial virtues as those of Peruvian bark or quinine. The statement that half putrid water is rendered an agreeable drink by mixing it with bruised cola nuts is not borne out by actual recorded experiments.

These nuts are now in much demand in the West Indies as a substitute for cacao in the manufacture of chocolate, which is deemed to be more nutritious than that made from the *Theobroma cacao*. The plant has been introduced in the Southern States, with poor results so far.

HAZELNUTS.

The hazelnut (*Corylus avellana*) is a large, many-stemmed shrub, a native of Europe and Asia. It is largely cultivated for the sake of its

nuts, which are consumed in great quantities as dessert fruits. The hazel tree is mentioned in very early writings, the specific name, Avellana, being derived from Abellina, supposed to be the valley of Damascus. It is said to have been introduced into Greece from Pontus; hence the nuts were called *Nux pontica* by the Greeks. Its fruits were esteemed by the ancients, and its shoots were employed as divining rods. Like other fruits that have been objects of culture for centuries, there are numerous varieties of the hazel; these are divided into two kinds—nuts and filberts—which are distinguished by their husks. The nuts have a short husk, or calyx, which in the filbert is much longer. These again are divided into varieties having long or short nuts, the latter bearing the name of cobnuts. The nuts of the wild hazel are small compared to some of its improved varieties, but they are sweeter than the cultivated kinds; its small size, however, makes it give place to the cultivated filberts and cobnuts of commerce.

These nuts are cultivated to a large extent in some parts of England. They are also cultivated in Spain and Italy. Those grown in Spain are known as Spanish or Barcelona nuts. The trade in these nuts is immense, about half a million dollars' worth being annually imported into England alone. Two kinds are received from Smyrna, known, respectively, as Turkey nuts, which are small and nearly round, and Turkey filberts, which are long and pointed. The nuts have a mild, farinaceous, oily, agreeable taste. The oil expressed from them is considered as being scarcely inferior to almond oil. They have also been used in the preparation of a poor kind of chocolate, and they are sometimes made into bread. The wood of the hazel is seldom of a size to be employed in the arts, although the roots, which are curiously veined, are sometimes cut into veneers. The young wood is very tough and elastic, and makes excellent hoops, fishing rods, and walking sticks. The celebrated magic wand, or divining rod, is said to have been formed of the forked young twigs. The wood makes good charcoal, from which drawing crayons are frequently made.

But little attention has been given to the culture of the hazel in this country. The fruit is largely imported, and its production here would probably be a profitable industry, as an average crop is stated to be about 1,500 pounds per acre. The plants are readily procured from suckers or layers, which are produced abundantly from the old plants. They are planted about 10 feet apart, and receive the ordinary treatment and care accorded to other orchard fruits. The plants are kept very dwarfed, as it has been found that by this means a larger crop, as well as a better quality of fruit, is secured. These dwarf plants are very uniformly rimmed with an open or cup-like center. The hazel has no special characteristics as an ornamental plant. It is a desirable marginal shrub in park plantations. A variety with purple leaves may be introduced with good effect in lawn groups. It is one of the best purple-leaved hardy plants.

The native hazel (*Corylus americana*) is found in thickets and on the margins of woods throughout a great portion of the United States. The nut is smaller than that of the European species, but it is sweet and palatable. It has not been cultivated to any extent as a commercial product. There seems to be much possibility in the culture of hazel nuts. One objection has in former years proved formidable against their culture, viz, the liability of worms injuring the nuts, but now that the application of insecticides is so well understood, this objection need not longer hold good.

MANGOSTEEN.

Garcinia morella.—The botanical origin of gamboge was long involved in some obscurity. It is a production of Siam, a country not well explored by the botanist. Gamboge is also received from Ceylon, and it has been ascertained that the Siam article is produced by the above-named species of Garcinia, and that from Ceylon from the same or a slightly differing variety. This Garcinia is a medium-sized tree, with large glossy leaves similar in appearance to those of the *Magnolia grandiflora.* The juice is collected by wounding the stems or breaking the young twigs of the tree and securing the yellow gum resinous exudations in hollow bamboos, where it is allowed to harden. Gamboge is seen in commerce in three distinct forms—in rolls or solid cylinders, in pipes or hollow cylinders, and in cakes. The two former are collected in hollow bamboos. The cake or lump gamboge occurs in round or square lumps, and is generally inferior in quality to the former, possibly from less care in collecting and in processes of preparation. It is employed as a pigment by artists in water colors and as a varnish for lacquer work; also in medicine as a powerful purgative. It is a dangerous poison in large doses, and forms an ingredient in most of the nostrums for tapeworms.

Garcinia pictoria.—This tree grows abundantly in certain parts of Mysore, in India. A fatty matter known as gamboge butter is procured from it. The seeds are first pounded in a stone mortar, then boiled till the butter or oil rises to the surface. It is used as a lamp oil and sometimes as food. It does not possess the drastic qualities of the gamboge resin, but it is considered antiscorbutic by the natives.

Garcinia mangostana.—The mangosteen apple tree is a native of Sumatra and the Moluccas, but has been introduced into various tropical countries for the value of its fruits, which are held in high esteem. It is a beautiful tree, with large leathery leaves and large rose-colored flowers. The fruit is round, about the size of an ordinary orange, with a shell resembling that of a pomegranate, but thicker and softer, and contains an astringent juice. In wet seasons it exudes a yellow gum, which resembles gamboge. The pulp is divided internally by thin septa, like those of an orange, only they are four-celled with one seed in each cell. The fruit is noted for its delicious flavor, or flavors, for those who have eaten it do not agree as to what it resembles. The plant is grown in conservatories, but requires a very warm atmosphere to cause it to perfect its flowers and fruit; hence its successful growth in Florida, where it is on trial, may not be realized.

SOY BEAN.

Glycine soja is a low-growing annual plant, resembling the well-known kidney or bush bean of the gardens. The seeds of this species are used by the Japanese and Chinese in the manufacture of the sauce which they call soy, or soja. This is said to be made by boiling the seeds or beans in water together with millet, wheat, or other grains, the mixture being allowed to ferment, and afterwards refined and stored for use. Soy is a thick, black liquid resembling molasses, but not so tenacious. This sauce is a favorite accompaniment to other food dishes in China and Japan. The leaves furnish a valuable oil, and the resulting cake is used for feeding animals and for manure to the fields of sugar cane in Southern China. These beans have frequently been recommended as a substitute for the coffee bean, but they are a poor substitute for it—about equal to scorched wheat or rye.

GUIACUM.

This medium-sized tree (*Guiacum officinale*) is a native of the West Indies, and is also found in Florida. It furnishes the hard, heavy wood called *lignum vitæ*, in much demand by turners. The heartwood is of a greenish-brown color, and the outer or sap wood is a light yellow. It yields a resin called gum guiacum, which exudes from the stem, but that obtained by boring holes in the newly cut logs is considered to be of most value. The logs are placed on a fire and the melted resin is collected from the holes. Guiacum is greenish-brown, with a balsamic fragrance. It is a stimulant of a very diffusable nature in the human system, and is used medicinally in chronic rheumatism, skin diseases, and other complaints. It is noted for the changes of color it undergoes when brought into contact with various substances. Gluten gives it a blue tint. Nitric acid and chlorine change it successively to green, blue, and brown. These changes are said to be due to the absorption of oxygen by guiacic acid, the active principle of guiacum.

LOGWOOD.

This tree (*Hæmatoxylon campechianum*), which yields the well-known logwood of commerce, is a native of Campeachy and other parts of tropical America, but is grown in large quantities throughout the West India Islands. It is an irregular, crooked-growing tree, attaining a height of from 20 to 30 feet. The heartwood is the part used for dyeing. It is of a deep, dull, brownish-red color, very hard and heavy. For the convenience of dyers it is cut into chips by means of powerful machinery. Logwood chips yield their color to water and alcohol, the latter extracting it more readily than water. The color of its dyes is red, inclining to violet or purple. Its aqueous decoction, left to itself, becomes yellowish and at length black. Acids turn it yellow, while alkalies deepen its color and give it a purple hue. Stuffs to be colored are previously prepared with aluminous mordants. A blue color may be obtained from it by the addition of verdigris, but the consumption of logwood is for black colors, which are obtained by alum and iron bases, and of any requisite degree of intensity. Logwood owes its coloring properties to a peculiar principle called Hematin or Hæmatoxylin, which, in some specimens, is found in such abundance as to be perceptible in distinct crystals. Hematin forms an orange-red solution with boiling water, becoming yellow as it cools, recovering its former hue when heated. Alkali converts it first to purple, then to violet, and lastly to brown, in which case it seems to be decomposed. Metallic oxides unite with it, forming blue compound. West India logwood is inferior to that received from Honduras and Yucatan. The former is used in the dyeing of carpets and other coarse cloths, while the Central American kind is employed for dyeing all kinds of woolen goods, cotton, and silk fabrics. The wood is of a very dense nature, and is not easily injured by exposure to the weather. It also takes a high polish. It is employed to some extent in medicine as a tonic and astringent. It has been rumored that the logwood tree has been found growing wild in Florida, and therefore its culture ought to be encouraged. Efforts to trace the authenticity of this rumor have not been successful.

RUBBER TREES.

Hevea brasiliensis is a tree of tropical America, which, with others of the genus, together with those of the genus Siphonia, furnish the Para rubber or American caoutchouc. The juice is obtained from wounds

made in the tree during the dry season, between August and January. It is collected in vessels and poured over molds, then dried by a gentle heat, successive pourings being made until a sufficiently thick layer is produced. At one time these molds were in the shape of shoes and bottles; hence the article was called bottle rubber. Sometimes alum is added for the purpose of coagulating the juice, and it is oftentimes dried over a thick white smoke, produced by burning the nuts of the *Urucuri* and other kinds of palms. The introduction of these rubber trees in the Southern States has been persistently advocated by various correspondents, but they are strictly tropical plants, for which no suitable climate can be found in the United States.

DOUM PALM.

This palm tree (*Hyphæne thebaica*) is found very generally over the continent of Africa and in parts of Arabia. It reaches about 30 feet in height, and the trunk is much branched, differing in this respect from most palms. In Upper Egypt, and in other places where it is found, its fruits form a source of food for the people, and its infusion with dates furnishes both a pleasant drink and an agreeable and reliable cure for fever. The fruit grows in large bunches, is of a yellowish-brown color, and has a thick, mealy rind, which tastes and looks like gingerbread; hence it is called the gingerbread tree. It is also known as the doom or doum palm of Egypt. Its leaves furnish roofing materials for the construction of dwellings; the trunk, split and freed from pith, forms the uprights and other parts in buildings. The down which is attached to the young leaves serves for filling mattresses and pillows. The ribs of the leaves and fibers of the root stalk form materials for making baskets and brooms. The kernels of the fruit are turned into beads, and made into small perfume boxes. In the Thebais this palm forms extensive forests, the roots spreading over the deeply buried ruins of one of the largest and most splendid cities of the ancient world. This palm would probably succeed where the date palm will flourish, but it is not considered to be as valuable as the latter

GRANADILLAS.

Passiflora quadrangularis.—This strong, rampant-growing, climbing plant is a native of South America and the West Indies. It has very beautiful flowers, which are succeeded by edible fruits called granadillas. These are oblong in shape and about 6 inches in diameter. They are externally of a greenish-yellow color when ripe, with a thick rind inclosing a succulent pulp, which is of an agreeable, but somewhat mawkish, taste. When mixed with wine and sugar, it is said to be of a grateful and cooling taste. The root is said to possess powerful narcotic properties, and is employed as a diuretic and emetic.

Passiflora laurifolia.—This plant is a native of Brazil and the West Indies. The fruit of this species is called the water lemon. It is about the size of a hen's egg, and when ripe is yellow and dotted with white spots. It contains a whitish watery pulp, which has a peculiar aromatic flavor, is delicately acid, and allays thirst.

Passiflora maliformis.—In the West Indies the fruit of this plant is called the sweet calabash, or apple-fruited granadilla. The fruit is round, about 2 inches in diameter, and is filled with a gelatinous agreeably tasted pulp, very much mixed with seeds, as are all of the fruits of this family. These plants are often grown in the South for their fruits, as well as for their beautiful flowers.

PISTACHIO NUTS.

Pistacia vera.—This is a low tree, a native of Western Asia, and has long been cultivated in Southern Europe for the sake of its fruits, called pistachio nuts. Its climatic requirements are similar to those of the olive. The fruit is a thin-shelled, oval, acuminate nut, which is esteemed by some as being of a more agreeable flavor than the filbert or almond, and, like the latter, is sometimes made into articles of confectionery. Peculiar horn-shaped galls are collected from the leaves, which are used in India for dyeing silk a green color.

Pistacia terebinthus.—This is a native of Southern Europe, Northern Africa, and some parts of Asia. It yields the chios or cyprus turpentine, which is procured by making incisions in the trunk, whence it flows. At first it is clear, of a honey-like consistency, and very fragrant, but quickly becomes thick and tenacious; but it ultimately hardens and is scraped from the bark. Galls, caused by the punctures of insects, are formed on the leaves, which are gathered and employed for dyeing and tanning purposes. One of the varieties of morocco leather is said to be tanned by them. It is sometimes called the terebinth tree.

Pistacia lentiscus.—This is found in the same regions as the last. The resinous substance called mastic is obtained from this species. Wounds are made in the bark, whence it exudes in drops, which are allowed to run down to the ground, where they harden into small semi-transparent globules and are collected for use. Mastic is used by the Turks and Armenians for strengthening the gums and to sweeten the breath. It is used medicinally as an astringent and by dentists to fill the cavities of carious teeth. The leaves and fruit furnish a coloring matter by boiling them in water and precipitating it by solution of salts ot iron. It dyes a fine black color, and, reduced to powder, is mixed with oil for painting. The pistacio trees will grow well in the Southern States. All of the species here mentioned have been subjects of distribution, but no detailed reports have been received relative to them.

RAIN TREE.

This tree (*Pithecolobium saman*) is a native of Brazil. It grows to a height of 60 to 70 feet, with an immense spreading head. The leaves fold closely up at night, so that they do not prevent the radiation of heat from the surface of the ground, and dew is deposited beneath its branches. The grass underneath the branches of this tree being thus wet with dew, while that under other trees is found to be dry, the name of rain tree has been given to it, under the supposition that the leaves dropped water during the night. The fruit of the tree is a pod from 6 to 8 inches in length and 1 inch in thickness, containing seeds which are surrounded by an amber-colored pulp of a sugary taste. These drop as they ripen, and are eagerly eaten by all kinds of live stock. Animals eating them fatten very quickly. They are often gathered, packed in barrels, and stored for use when other kinds of food become scarce. It is considered to be equally as valuable as the carob bean for mixing with the food of horses and cattle. It is said to be wonderfully prolific. It has been introduced into the West Indies. In Jamaica it is called guango. The plant is rather tender for this country, so far as its fruit products are concerned.

PATCHOULI.

Pogostemon patchouli is a tall shrubby herb, a native of Penang, Sylket, and the Malay Peninsula. The leaves yield the peculiar perfume

known as patchouli. The odor is due to a volatile oil which is obtained by distillation of the leaves and young shoots. The oil is of a yellowish-green color, and almost as heavy as water. It is a very popular perfume in India, and is held in great favor by the Hindoos. It is used for scenting tobacco and as a perfume for the hair. The scent is more powerful in dry than in damp places. Sachets of patchouli consist of the coarsely powdered leaves mixed with cotton wool and folded in papers. The source of this perfume was long held as a secret, and genuine Indian shawls and Indian ink were tested by the presence of this odor. The oil is now distilled in Europe from dried leaves, and its presence is, therefore, no longer a test for genuine Indian goods. The odor of patchouli is disagreeable to many persons, and ill effects to the nervous system have been ascribed to its excessive use. In appearance the plant much resembles a coleus. Its cultivation is carried on almost exclusively by the Chinese in the Straits Settlements. The plants are raised from cuttings, which are planted in rows about 2 feet apart, in rich soil, and carefully weeded and cultivated. The plants are ready for cutting about six months after planting, when they will be from 2 to 3 feet in height. They are cut and treated similarly to tobacco. They are dried in the sun for several days, but not permitted to get wet by dews or rains. When the leaves have dried they are baled for sale.

RHUBARB.

The common rhubard (*Rheum rhaponticum*), together with *Rheum andulatum* and *Rheum tartaricum*, is the original species whence have been derived the many hybrid varieties now cultivated under the name of pie plant for the culinary uses of their leaf stalks.

The species are natives of Asia. They are herbaceous perennial plants with large deep green leaves supported upon long fleshy footstalks, which are used as a substitute for fruit, for making preserves and sauces. These have a pleasant, sharp flavor, due to the presence of oxalic and other acids. Some of the hybrid varieties yield a milder juice than the species, which is further secured by cultivation in rich soils, which tends to increase the thickness of the leaf stems and at the same time reduces the amount of acid contained in their sap.

When near maturity, the stalks become more fibery, but full of juice, which is sometimes expressed, and with the addition of sugar is allowed to ferment into a kind of wine, which is a very palatable drink, but of questionable benefit to health.

The unexpanded flower heads have been used as a vegetable, under the name of rha-flower, and are said to form a dish of fine quality and delicacy when cooked as greens. The leaves are sometimes dried and smoked as a substitute for tobacco. The agreeable taste and odor of rhubarb are not brought out in the leaf stalks until they are cooked. The chief nutrient in these is the sugar (glucose) which they contain, and which amounts to about two parts in one hundred parts of the fresh stalks. Its sour taste is due to oxalic acid, or rather to the acid oxalate of potash, oxalate of lime being also present.

The food value of rhubarb is very small. The commercial value of rhubarb is in its dried roots. The origin of commercial rhubarb is multiple. It is mentioned by early writers as having been brought from beyond the Bosphorus. It is said to have been mentioned by Chinese writers four thousand five hundred years ago. The rha, which came into Europe by the ancient caravan routes from Northern China, by Bokhara and Asia Minor, was naturally called rha-ponticum, and that by Russia

and the Danube, rha-barbarum. The designations Turkey, Russian, East Indian, and Canton rhubarb merely indicate the commercial channels through which the article has been derived in modern times.

Besides *Rheum rhaponticum*, which yields the rhapontic rhubarb, there is *Rheum palmatum*, to which has been attributed the origin of Persian, Turkey, Russian, Muscovite, and Kiachta rhubarbs. Indian and Chinese rhubarbs are stated to be produced by *Rheum emodi*, *Rheum Webbianum*, and *Rheum australe*, the first two of these being considered by some authors as being merely synonyms of the last. It is now generally admitted that the true source of the best rhubarb of commerce is *Rheum officinale*. This species is a native of Thibet. It is a plant of robust growth, often reaching 5 to 6 feet in height, and produces large heavy masses of flowers. The leaves are sometimes 5 feet long. The ordinary species of rhubarb are herbaceous perennials, with a thick rootstock and deciduous leaves. In *Rheum officinale*, after the third or fourth year from seed, the rootstock gradually decays and a stem is formed above the ground; the plant then derives its nourishment from small roots, which can not be employed in medicine. These stems have thick branches, often 6 to 8 inches in diameter. The portion used in medicine is therefore the stem, and not the rhizome or root.

Seeing that the sources of rhubarb are so numerous, it may well be expected that its commercial distinctions and medicinal values are equally varied. The quality of the article will be influenced by its botanical origin, the climate and soil in which it was grown, the age of the root, the season when gathered, the method of collection, the process of drying, and its final preparation for market. The portion of the plant which constitutes the drug will also influence its value. The article furnished by the stem, or a part very close to the stem, will differ from one obtained from the root. Good rhubarb has a bitter, astringent, and somewhat aromatic taste, and feels gritty to the teeth, owing to the abundance of small crystals of oxalate of lime which are contained in it. It has a very delicate odor, and is covered with a fine yellow powder, and the pieces when broken present a mottled red and yellow color, owing to the passage of a number of wavy carmine-colored streaks through the yellowish-white matrix. Here and there are small spots of a darker color.

It is considered that very much of the appearance, and supposed difference in quality, of the commercial rhubarb is wholly owing to the time of lifting the root and the care given to its preparation for market. The Chinese dig up the roots early in spring, just before the leaves appear. After lifting, the roots are divested of all small fibers, and the soil and other impurities removed by washing. They are then allowed to dry a day or two in the sun, then cut in slices, and after exposure to the sun for four or five days longer, during which time they must be turned over several times daily to prevent molding, a hole is bored in each slice, which is then strung on a thread until sufficiently dry. They are put through a finishing process by being placed in a close cylinder, where they are subjected to abrasion by the rapid revolution of the vessel. This smooths their surfaces, liberating at the same time a fine dust or powder, which envelops each piece with a fine bloom, like that upon the surface of a ripe plum. A considerable quantity of rhubarb root is imported into this country for medicinal purposes. This might profitably be grown here, provided that species of plants which yield the best article could be procured for that purpose. Large quantities are grown in England. The English rhubarb

is of a light spongy texture; its taste is astringent and mucilaginous, but destitute of the aromatic and gritty qualities possessed by the more highly esteemed kinds. It is probable that the root as grown in the warmer climates of this country would be equal to the best article of the kind now in commerce. The slow sun-drying process adopted in other countries might here be completed in a few hours in a drying apparatus by artificial heat. This would insure against danger from moldiness and secure good color and flavor with more certainty than when the drying process is wholly dependent upon the direct heat of the sun.

Rhubarb is cultivated very extensively for the sake of its leafstalks. To render these crisp, tender, and succulent, the plants must be grown in rich soil. A light, sandy loam heavily manured yields the best crop, but it requires to be deeply worked to afford the best results. The plants are usually propagated by dividing old roots into sections, each section having a bud. Plants are also raised from seeds sown in spring in rows like peas; when the young plants appear they are thinned, so that those left are 3 or 4 inches apart. After the growth of one year they are ready for removal. In a permanent plantation the plants are set in rows which are 4 feet apart in each direction. The soil is kept clean from weeds and stirred frequently during the summer to promote growth. Where the winters are severe a covering of manure is spread over the plants to protect them. When the plant is cultivated for its root the same preparation and treatment are given. In field culture a light plow furrow should be made on each side of the rows, thus covering the crown buds of the plants with a layer of soil, which will form a ridge to throw off water. In spring this ridge will be smoothed down with a light harrow. The roots will be large enough for removal at the end of four years' growth, though it is supposed that a further growth of one or two years increases their medicinal value.

CAMPHOR.

The camphor of commerce is derived from a tree known as *Camphora officinarum* (C. Bahn), and is a member of the Laurel family.

The date at which the Chinese discovered the production of camphor from this tree is unknown. The tree is distributed throughout the eastern provinces of Central China, on the island of Hainan, and very extensively in Formosa. It also occurs as a forest tree on the islands of Kiushiu and Shikoku of South Japan, its growth being much more vigorous there than in the more northern localities. This kind is called "Laurel camphor," or "common camphor;" it is the ordinary camphor of commerce, and is produced almost exclusively from the camphor laurels of Formosa and Japan.

The large and increasing quantities of this drug consumed in all civilized countries make the question of its continuous production and regular supply a matter of considerable importance. It is a well known fact that the sublimation of the crude camphor from the wood is conducted in a primitive, careless way which causes great waste. The camphor laurels of Formosa are gradually being destroyed under the careless system employed by the Chinese gatherers. In fact they have been entirely exterminated along the seaboard, and the wood is now obtained from the forests along the frontier between the settlements of the Chinese and the inland mountainous regions still occupied by the aboriginal population. The camphor gatherers are thus continually exposed to the assaults of the natives, which interrupt the profitable

prosecution of this industry. No attempts are made towards planting other trees to take the place of those destroyed, and a sufficient quantity of the drug is obtained only by constant encroachments upon the territory of the Formosans, the trees being thus destroyed still further into the interior at every new move, gradually exhausting the supply.

The trees are felled and the small branches chopped up. These, with the chips and twigs, are alone used, the heavy wood being abandoned. A long trough made from a hollow tree and coated with clay is placed over eight or ten hearth fires, and is half filled with water. Boards perforated with holes are put across the trough, and above each hole is a jar filled with chips of the wood, with earthenware pots inverted above them, the joints being made tight by hemp and clay. The water in the trough is heated to boiling, and the steam passing through the holes saturates the chips, causing the camphor to sublime and condense in crystals in the inverted pots above. The camphor thus obtained is sent from the interior of the island to Tasmin, the principal port, packed in baskets covered with cloths and large leaves. On arrival it is repacked in tubs or lead-lined cases for export by Chinese vessels to Hongkong, Shanghai, or Canton; the loss by evaporation while in transit from the place of its production being very large. A yellow oil exudes from the packages of this crude camphor, which is collected and locally known as "oil of camphor." The Formosa camphor sometimes goes by the name of "Chinese camphor," and it sometimes arrives in India in a semi-fluid state, owing to the addition of water before shipment.

The Japan camphor used to be extracted by boiling the wood with water in an iron kettle and condensing the vapor in an earthenware dome closed at the top with rice-straw. The modern practice is to distill the wood with water in an iron retort fitted with a wooden dome, from which the vapors are led through a bamboo tube to the cooling apparatus. This consists of a wooden box containing seven transverse compartments and is enclosed in a second box through which water is allowed to flow. The vapors are conducted through all the compartments in succession by means of holes placed alternately at either end of the dividing walls.

The Japan camphor arrives dry. It is lighter in color than the Formosan and somewhat pinkish. It arrives in double tubs, one within the other, without metal lining; hence it is sometimes called tub-camphor.

These details are noted for the purpose of showing how the crude camphor is obtained at present; but when the production of the article becomes an industry in this country, as appears quite probable, undoubtedly vast improvements will be made over these primitive methods.

INTERROGATORIES AND REPLIES.

The following interrogatories and replies have been selected as indicative of the character and scope of the information furnished by this division:

COFFEE.

G. C. (California).—I am anxious to experiment in the growing of coffee. Think that I have the soil and climatic conditions that will insure success. Will you oblige me with all the data regarding the planting, care, gathering, and drying that you may think will be of value to me, and where I can procure berries for seed?

REPLY.—Coffee not being grown for commerce in the United States, we can only briefly recite what is known relative to its culture in tropical countries. In the first place, it is stated that the crop can not be made successful in a climate where the thermometer ever goes as low as 50° F.; some authorities place the figure at 55° F.

The plants are usually set about 10 feet apart, and they are pruned down to about 7 feet in height, to facilitate gathering the berries. After gathering, the berries are washed, in order to remove the pulp, and afterwards spread out in the sun to dry, usually on a cement floor, provided with sheds under which the coffee is raked to avoid rains or heavy dews. After drying, they are passed through a machine to remove the scarf which envelopes each berry; they are then sorted and bagged for market.

The berry soon loses its vegetative powers, so that seed should be procured from Mexico or the West Indies, direct from the plantations, with as rapid transit as possible.

NIAULI.

G. K. B. (*Louisiana*).—I would be much gratified at receiving a few seeds of the tree called niauli. I take great interest in trees, and would like to find one which would serve to reduce malarial diseases in this climate.

REPLY.—Niauli is a local name given to an oil which is distilled from the leaves ot a small tree in New Caledonia. The plant is *Melaleuca vividifolia*. The oil is not of commercial value. It would be a very difficult matter to procure seeds of this plant, even if it were important to do so. The plant would not endure the climate of Louisiana to begin with, and would not be of any particular value if it did. Plants of the genus are sometimes to be found in botanic greenhouses, but there is no economic value attached to them. As to a tree which would reduce malarial diseases, mention might be made of the blue gum tree of Australia, which has been recommended for such a purpose because of its large system of foliage requiring much moisture for evaporation, thereby draining wet lands to some extent. This tree will not live in Louisiana. Probably any heavy foliaged tree of rapid growth, such as the Carolina poplar, would answer a like purpose.

CARDAMOM.

C. W. H. (*Washington*).—Will you kindly inform me of the most suitable soil for producing, and the best adapted climate for the culture of, the cardamom?

REPLY.—Cardamoms are produced by various plants of the ginger family, natives of strictly tropical climates. There is no part of the United States where they could be grown.

ORRIS ROOT.

A. W. K. (*Detroit, Mich.*).—Please give me what information you can in regard to the culture of orris root, as I think it could be grown to advantage in this country.

REPLY.—It is quite probable that orris root could be made a profitable culture in this country. *Iris florentina* and other species of iris furnish the orris root of commerce. When cultivated for the root, the plants are set out in rows and treated very similarly to potatoes during summer. The roots are taken up in the spring and prepared for use. The tops, with a small portion of tuber, are cut off and replanted for further growth, much in the same way that horse-radish is treated. The young or newly planted tops will make saleable roots after three years' growth. Rich and somewhat damp soil is said to furnish the best roots.

CANAIGRE ROOT.

J. P. (*Kentucky*).—We have been trying for some time to learn where the canaigre beet is grown. This beet is said to contain an immense lot of tannic acid. If you know anything about this plant, as to where and how it is grown and how to procure seeds or bulbs, we would be obliged for the information.

REPLY.—Canaigre is a name given to the root of a dock called *Rumex hymenosepalum*. It grows plentifully in sandy soils over a large territory on both sides of the Rio Grande, and from there northward over a large portion of western Texas. The bulbs are produced in clusters, like some kinds of sweet potatoes. An analysis of this root will be found at page 119 of Report of this Department for 1878. From this analysis it appears that the root contains about 23 per cent of tannic acid, and has been long used by Indians and Mexicans for tanning hides. No reports have been received which would indicate that the plant is a subject of cultivation, the present supply being furnished by plants growing naturally in the places whence they are collected. The plant grows freely from roots, and as it also seeds abundantly the latter might be procured from its native habitats. This Department is not at present advised as to how roots or seeds can be procured.

SOJA BEAN.

E. P. D. (*Massachusetts*).—Can you inform me if the soja or Japan bean is cultivated in this country? It is said to be valuable as an article of food, being more nutritious than meat.

REPLY.—The soja bean has been grown more or less, chiefly as a novelty, in this country for many years—for half a century at least—but has never gained recognition as being of special importance. It has been recommended for the oil contained in it, as a substitute for coffee, etc. It is said to be used in Japan mainly as an ingredient in a sauce called soy. Seeds can be obtained from most of the large seed stores in this country.

MEXICAN JUMPING BEANS.

G. R. (*New York City*).—You have doubtless heard of the Mexican jumping bean. Will you be kind enough to inform me whether this bean actually grows in Mexico; and if so, in what section? Also tell me the true name of it, and what it is used for, if it is used at all.

REPLY.—Mexican jumping beans are the seeds of a shrub which is found about Alamas, Sonora, and other parts of Mexico. The movement is caused by the antics of a larva which infests the bean, and which looks like the common apple worm of our orchards. The name of the plant which produces these beans is *Sebastiana palmeri*, and the name of the worm is *Carpocapsa saltitans*. It has no particular value.

INDIA RUBBER TREE.

G. K. K. (*Florida*).—Will you kindly inform me where I can obtain seeds of the rubber tree, *Ficus elastica*, and whether the rubber could be produced in this State at a profit?

REPLY.—Seeds of this plant are not in commerce; hence they could not be easily procured. The plant is extensively propagated by cuttings, which readily form roots. It is doubtful if rubber can now be profitably produced from this tree, even in India, as it is understood that the rubber supply is mainly from Central and South America, and from a different class of plants. Very little, if any, of the rubber of commerce is collected from *Ficus elastica*. It most assuredly could not be produced in Florida at a profit.

GRAPE SEEDS.

C. H. M. (*Indiana*).—I have several times tried to get seeds taken from raisins to grow. I have planted them in rich soil and set them out to freeze, and treated them in several different ways without success. What is the matter?

REPLY.—Grape seeds, like many other kinds of seeds that have become old and hardened, take a long time to vegetate. Probably the matter in your case was impatience. They have been known to vegetate three years after sowing. Palm seeds have vegetated five years after planting.

PEAR TREE BLIGHT.

J. W. H. (*Georgia*).—I will appreciate very much if you can send me the best remedy for pear blight.

REPLY.—No certain preventive for pear blight has yet been announced. Usually it is advised to carefully watch for the first appearance of the disease and remove the branch thus affected. In this case it is important to cut back until clean healthy wood is reached. Thousands of trees have been saved by prompt action in removing diseased branches, and have remained healthy and productive for an indefinite time.

A precautionary measure, which has been well tested for thirty years, is to wash the trunk and main branches of the pear tree with a mixture prepared as follows: Take 1 bushel of lime and place it in a barrel with 10 pounds of sulphur, and slake the lime with hot water. After it has settled stir it thoroughly and apply it to the trees as ordinary whitewash is applied to surfaces. It has been sufficiently proved that no part of a tree thus covered will be attacked by blight, but parts not so covered are liable to be attacked, although it rarely happens that they are; the emanations from the sulphur exercise a salutary influence in checking the disease.

FIG CUTTINGS.

M. F. C. (*Arkansas*).—Will you please inform me the best way to plant fig cuttings? They are full of buds. How should they be planted?

REPLY.—Fig cuttings are made of 1-year-old shoots, cut into lengths of 8 inches; plant about 4 inches apart in rows in deep mellow soil; they should be inserted deep enough to cover the entire cutting except the uppermost bud, which should be level with the surface of the soil.

OLIVES.

J. B. W. (*Louisiana*).—I make application for a small quantity of olive seed. A Creole planter believes he can make a success of olive culture in southwest Louisiana.

REPLY.—The Department does not furnish seeds of olives, and does not encourage their growth by this method, as plants from seeds are not reliable and likely to produce very inferior kinds of fruits. The Department propagates olives by cuttings taken from a collection of named varieties imported from Europe of selected sorts. Plants of these varieties can be forwarded on application.

CALLA LILY.

J. S. (*Seattle, Wash.*).—I see by the papers that the Department is engaged in introducing the calla lily as a new vegetable root for the table.

REPLY.—A paragraph of this purport has been going the round of newspapers for several months past. The statement has no foundation in fact. The calla root has no qualities fitting it as a food product.

NUTMEGS.

R. S. (*Riverside, Cal.*).—Wishing to try the experiment of growing nutmegs, I write asking information regarding their culture.

REPLY.—The culture of nutmegs in the Molucca Islands and in the Banda Isles is very much the same as that given to a peach orchard. The fruit, when on the tree, looks very much like a peach. The tree grows about 20 feet in height. It can not be successfully grown in any part of California, as it requires a tropical climate.

ORANGE CULTURE.

F. M. (*Florida*).—Please oblige me by giving me some information how to treat young orange trees when they commence bearing. The advice of one of my neighbors is not to cultivate too much. Another says they need all the cultivation they can get. I have decided to follow your opinion.

REPLY.—It is impracticable to decide definitely upon a question of this kind without an inspection of the trees. This much might be said: that at no time should the ground be cultivated deeply over the roots of orange trees. Their roots are inclined to run near the surface, and destroying them by deep culture is harmful to the tree. After the month of August surface culture, as a rule, should cease, except so far as to the cutting down of surface weeds, as the trees should not be excited to growth at this time, as the thorough maturing of the yearly shoots is all important before the cold of winter overtakes them.

REPORT OF THE CHIEF OF THE SEED DIVISION.

SIR: I have the honor to submit herewith a report of the operations of the Seed Division for the calendar year 1893.

Very respectfully,

M. E. FAGAN,
Chief.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE YEAR.

RECORD OF SEED DISTRIBUTED.

The following tables show the number of papers of seed distributed during the fiscal year ending June 30, 1893, together with the kinds and varieties, and the persons or associations to whom such distribution was made:

Statement showing the kinds and quantities of seed issued from the Seed Division of the Department of Agriculture, under the general appropriation act of Congress, from July 1, 1892, to June 30, 1893.

Description of seed.	Varieties.	Senators, Representatives, and Delegates in Congress.	County statistical correspondents.	State statistical agents.	Agricultural associations, experiment stations, and miscellaneous applicants.	Total.
		Packages.	*Packages.*	*Packages.*	*Packages.*	*Packages.*
Vegetable	240	5,689,304	422,925	104,370	526,987	6,743,586
Flower	78	418,090	1,485	510	405,960	826,045
Honey plant	1				89	89
Sunflower	1	78	10	2	235	325
Tobacco	14	59,886	263	35	3,751	63,935
Field:						
Wheat	1	2			133	135
Corn	6	7,893	59	57	4,953	12,962
Barley	1				48	48
Kaffir corn	1				19	19
Sorghum	8	2,476	18	2	551	3,047
Turnip	12	77	70	58	3,468	3,673
Sugar beet	4	3,417	1	1	1,141	4,560
Mangel-wurzel	2	59	7	6	539	611
Grass	7	12,942	59	35	5,131	18,167
Clover	3	259	16	30	2,345	2,650
Millet	1			4	11	15
Forage plant	1	3			51	54
Textile:						
Cotton	6	21,295	92	32	3,603	25,022
Total		6,215,781	425,005	105,142	959,015	7,704,943

Statement showing the kinds and numbers of papers of seed sent to foreign countries by the Seed Division of the U. S. Department of Agriculture during the fiscal year ended June 30, 1893.

Countries.	Vegetable.	Flower.	Tobacco.	Clover.	Grass.
Argentine Republic	15		10		
Canada	115	150			1
China	20				
Congo	25				
Corea	20				
Costa Rica	10	10			
Denmark	45	60			
Ecuador	15				
England	32	45	7		
France	15				
Germany	14			1	
Honduras		40			
Spanish Honduras	36				
India	16	10			
Ireland	20	20			
Italy	29				
Japan	36				
Liberia	50				
Mexico	30				
Nicaragua	15				
Sandwich Islands	10	10			
Scotland		10			
Sierra Leone	15				
Tahiti	300	130			
United States of Colombia	20				
Uruguay	28	10			
Venezuela			6		
West Indies	60	10			
Total	991	505	23	1	1

REPORTS FROM RECIPIENTS OF SEEDS.

Each one of the 7,706,464 papers of seed distributed bore upon its face a request that the result of the trial of the seed contained therein be reported to the Department. An average of five papers to each person would place the number of recipients of seed at 1,541,000 persons. Of this number 1,483 persons acknowledged the courtesy of the Government by making a report of their trial of the seed, such report being coupled usually with a request for more seed, "so that an intelligent report might be furnished the following year."

The above number of reports, distributed by States and Territories, is as follows:

Alabama	33	Nebraska	33
Arkansas	24	New Hampshire	7
California	57	New Jersey	2
Colorado	12	New York	86
Connecticut	5	North Carolina	18
Delaware	4	North Dakota	35
Florida	36	Ohio	92
Georgia	22	Oklahoma Territory	36
Idaho	9	Oregon	65
Illinois	65	Pennsylvania	56
Indiana	38	Rhode Island	1
Iowa	102	South Carolina	26
Kansas	37	South Dakota	20
Kentucky	22	Tennessee	11
Louisiana	25	Texas	72
Maine	14	Utah	5
Maryland	17	Vermont	25
Massachusetts	43	Virginia	30
Michigan	38	Washington	50
Minnesota	32	West Virginia	7
Mississippi	42	Wisconsin	50
Missouri	53		
Montana	26	Total	1,483

The reports in detail have been omitted owing to the vague and indefinite language in which they are couched, conveying no useful information as to time of planting, nature of soil, cultivation, or adaptability to climate. In view of these facts it would be manifestly improper to burden the pages of this report with columns of useless matter.

KIND OF SEED DISTRIBUTED.

Three hundred and eighty-seven varieties of seed were used in the distribution, many of them so old and well known as to hardly require the formality of printing the name upon the package. A study of the history of this division for many years past reveals the fact that the "new and valuable" seeds distributed were known and catalogued by nearly every prominent seedsman of this country and Europe for at least two years before their purchase by the Department.

ANNUAL COST OF SEED DISTRIBUTION.

The cost of the distribution for the fiscal year 1892-'93 amounted, in round numbers, to $160,000, making an average cost of about 2 cents per paper for each paper of seed distributed exclusive of the cost of transportation through the mails of over 275 tons of matter.

RECOMMENDATIONS.

Many suggestions, valuable and otherwise, have been made in the annual reports of this division relative to the methods which should be pursued in order to obtain the best results from the distribution of seed; but every one of my recent predecessors has ignored or overlooked the fact that for many years no useful purpose has been served by the continued enlargement of the quantity of seed purchased annually, and its indiscriminate distribution to those who by accident or design become the recipients of this gratuity.

The purchase, propagation, and distribution of seed were begun at a time when but a few of the now thickly populated States held within their limits a propagating garden or seed farm. The conditions, however, have changed and in nearly every State of the Union may be found large establishments built up by private industry and private capital, engaged in the business of raising new and valuable seed, and in the propagation of rare plants, trees, and flowers.

In this industry, which is no longer an "infant industry," many thousands of acres of land are annually cultivated, giving employment to thousands of skilled and unskilled laborers. The proprietors and managers in order to advance their interests are ever on the alert for new and valuable seeds, giving to their propagation as much care and attention as a loving mother gives to her offspring, and if their efforts bear fruit and something new is produced the discovery is made public through the medium of the trade journals and catalogues, and the public may receive the benefits by purchasing the product at the usual market price instead of waiting two or more years for this division to drop a package of the new discovery in their post-office boxes.

In view of these facts does it not appear that the Seed Division has outlived its usefulness, and that its further continuance is an infringement of the rights of citizens engaged in legitimate trade pursuits, in

which they have invested their capital, and upon which the maintenance of their families and their employees depends.

Instead of recommending an increase in the capacity of the building now occupied by this division, as is customary in the Annual Report, it would seem to me more proper to urge the retirement of the Department from the seed business, and that the building now occupied for that purpose be devoted to some useful pursuit, more in keeping with the spirit of our institutions.

REPORT OF THE CHIEF OF THE DIVISION OF ILLUSTRATIONS.

SIR: I have the honor to submit my fourth annual report, which contains a brief statement of the work of this division for the calendar year 1893.

Very respectfully,

GEO. MARX,
Chief.

Hon. J. STERLING MORTON,
Secretary.

The past year has been an unusually busy one, and the augmented demand for illustrations from the various divisions has been promptly met. The number of illustrations completed during the year comprises 777 plates, representing over 1,660 figures and including large water-color paintings and map drawings, besides the more commonly used methods of reproduction.

The following represents the work done for the several divisions of the Department:

Divisions and offices.	Number of plates.	Divisions and offices.	Number of plates.
Fiber Investigations	1	Ornithology and Mammalogy	69
Microscopy	3	Botany	82
Chemistry	7	Animal Industry	104
Records and Editing	10	Pomology	162
Experiment Stations	16	Entomology	149
Statistics	34	Miscellaneous	5
Forestry	45	World's Columbian Exposition	42
Vegetable Pathology	49		

The exhibit of the Division of Illustrations at the Columbian Exposition was prepared with the intention of showing the functions of the division in illustrating the scientific work of the Department as well as the different methods employed in reproducing these illustrations as they appear in the publications. These exhibits attracted great attention and earned many commendations.

One of the assistant wood-engravers was sent to Chicago for five months, from May to September, to take charge of the exhibit and demonstrate the art of scientific wood-engraving for the benefit of the visitors to the Fair.

On account of the absence of one of the wood-engravers (on duty at the Fair) the wood-engraving branch of this division has completed only 38 full-page plates, the work being confined, as heretofore, almost exclusively to illustrations for the Divisions of Forestry and Botany. The

suggestions offered in last year's report, as to the advantage of extending this method of reproducing illustrations to the work of other divisions, holds good at this time. In this connection it will be interesting to refer to a discussion on this subject at a recent meeting before the Association of Economic Entomologists, during which Prof. Garman, of Lexington, Ky., who seems to be well informed on the subject, says:

Wood-engraving is better. It is not open to any of the objections against etching and lithography. It can be easily and cheaply duplicated. It yields a clear, neat figure when printed on only fair paper. It can be used in plates or scattered in text. * * * The figures published by Prof. Riley in his Missouri reports are still among the best we have. * * * It may be true that their success is not entirely due to the fact that they are wood-cuts, but it is equally true that they would never have become so well known, or so universally used, if they had been produced by any other method. * * * But the plain truth is, that with all of its disadvantages, wood-engraving remains our most satisfactory method of making illustrations.

Prof. Garman is quoted at length because he has expressed an unbiased judgment founded on experience as to the value and advantages of wood-engraving over all other methods of reproducing illustrations. It is admitted that wood-engraving is expensive in the first outlay, but the fact should not be lost sight of that the duplication of the cuts by electrotyping saves the cost of redrawing the subject, which would ordinarily occur if any other method were employed.

The work of the electrotype-room continues to increase by the accession of plates from recent publications, and its usefulness is daily demonstrated.

REPORT OF THE CHIEF OF THE DIVISION OF RECORDS AND EDITING.

SIR: I have the honor to present herewith my fourth annual report, covering the work of the division for the calendar year 1893.

Very respectfully,

GEO. WM. HILL,
Chief.

Hon. J. STERLING MORTON,
Secretary.

During the calendar year 1893 the total number of publications handled in this division was 210. These varied in size from circulars of information and farmers' bulletins, ranging from 8 to 32 pages each, to the more extensive publications in the form of special bulletins and reports, and including the Annual Report of the Department for 1892, the Annual Report of the Weather Bureau and that of the Bureau of Animal Industry, the first of which is a book of some 650 pages. These publications aggregated altogether 13,082 printed pages and a total of 3,446,181 copies. This is, of course, exclusive of the daily weather bulletin and the weather maps published daily by the Weather Bureau, which do not pass through this division. Of the total number of publications given above (210), 88 are publications of the Weather Bureau, and were printed at the Weather Bureau by its own printing office. Of the remainder (122) 4 were printed by order of Congress and paid for from appropriations provided in the resolutions ordering the same; 118 were paid for either from the fund appropriated for the public printing and binding, amounting for this fiscal year to $85,000, while others again have been charged to the funds of various divisions whose appropriations specially provide for printing. The proportion of total printing expenses chargeable to each division is shown in a table at the close of this report.

It should be stated that the work included in the table in question embraces not only the bulletins, reports, and circulars printed for distribution, but the blank books and blank forms required in the Department work, and also the necessary bookbinding for the library and for sundry divisions.

In addition to the supervision, editing, and preparation for the printer of all the publications of the Department, the division is charged with a certain supervision of the printing of circulars, office stationery, etc., done in the printing office of the Department, all proofs of printing work done in that office being submitted to this division.

FARMERS' BULLETINS.

The series of publications to which the name Farmers' Bulletins has been given has been continued with very practical results, a large amount of useful information having been widely distributed in this form, which effects the greatest economy. The practical nature of the subjects handled and the plain manner in which the information is expressed have made these publications deservedly popular among practical farmers, and, although their cheap form has permitted the printing of very large editions, yet frequent reprints have been necessary to supply the continued urgent demand.

In this connection it would be well to renew the suggestion made in a previous report, that wherever possible the first presentation of results obtained from the investigations of the Department should be in the form of Farmers' Bulletins. The great bulk of the people whom the Department is specially designed to serve do not ask for more than the results of the Department work and the conclusions they justify presented to them succinctly and in the plainest terms. They do not require to be informed as to the details of investigations and the processes by which these results were obtained. At the same time this suggestion is not designed to propose bulletins of this class as a substitute for the full reports of all the work done, a full record of which is essential for the information of scientific workers in the same field and for the benefit of the Department workers of future years. As a matter of economy, if for no other reason, the Farmers' Bulletins must become the popular medium for conveying information of a practical nature to the farmers generally, and the adoption of this plan will enable us to restrict the size of the editions of the more pretentious and technical publications which involve greater expense.

CLASSIFICATION OF PUBLICATIONS.

A systematic classification of the publications of the Department, with a view to greater simplification, is very much to be desired, but for obvious reasons should not be hastily undertaken. As a suggestion in the direction of classification, a division of the Department publications into four main classes is recommended. First, those of a purely scientific nature. The editions of these could, it is believed, be limited to 2,500 or 3,000 copies, and, being prepared by scientists more exclusively for the use and information of their scientific confrères, time and space could be saved by the free use of technical language. These should not be included in the monthly list of the publications of this Department, which are circulated widely for the information of people who desire to obtain our publications.

A second class should consist of reports and bulletins of a special character, which may be termed technical in so far as they are adapted to persons following a special calling, such as horticulturists, dairymen, live-stock breeders, etc. While designed to be more popular than publications of the first class, rendering simple language more desirable, these might still be more or less technical in character, and, except in rare cases and for very cogent reasons, editions of this class could be limited to about 5,000 copies.

A third class of publications should consist of the Farmers' Bulletins and circulars of information, one or other of these forms being generally available and sufficient for conveying information where a more extensive distribution than provided for in the second class is needed.

The fourth class should consist of maps, charts, and such other publications as demand a special and peculiar form.

At present all publications, with the exception of the Farmers' Bulletins, are issued in a separate series for each division, a plan which, while unavoidable, perhaps, in reference to the first and last classes enumerated, should be if possible modified as regards the other classes. With the growth of the Department, the accession of new bureaus and divisions, the increasing number of serials and the duplicating of numbers, and the indiscriminate number of reports, special reports, bulletins, etc., issued by the Department, there is certain to arise a confusion sufficient to distract librarians and bibliographers. And the fact must not be forgotten, in citing this phase of the subject, that it is essential to the interest of the scientist himself, as well as to the people at large, that all publications should be properly classified, so that they may be correctly referred to and easily found by those having occasion to use them.

SERIAL PUBLICATIONS.

One of the serious obstacles to a proper and simple classification of the publications of the Department is to be found in its serials. Few of these are either distinctively scientific, technical, or popular. The result is that a serial, from its nature, not only reaches a comparatively limited number of persons in comparison to the cost of publication, but a great deal of the matter is wasted, scientific articles being placed in the hands of people who neither want them nor are interested in them, while popular information is distributed to persons who do not need it. The tendency of a serial is generally antagonistic to what should be, in the interest of economy, a cardinal principle of the Department publications, namely, to confine publications as much as possible to one class and to one subject, in order that every copy printed may be available to some person who needs it. The issue of publications in serial form necessarily results in a list of regular recipients, none of whom wish to lose a single number and thus leave their sets incomplete, even though many of the numbers may contain nothing of special interest to them. The result is that a serial including, in a twelvemonth 96,000 copies, and supplying, we will say, a regular list of 6,000 persons, leaving 2,000 copies of each edition for general distribution, will in the aggregate, therefore, reach no more than 25,000 to 30,000 people, and yet very possibly not more than a few hundreds out of the 6,000 persons supplied regularly have found matter of special interest or particularly instructive to them in more than two or three numbers. If serials are to be permitted, their range of subjects should certainly be restricted, and they should be of a purely scientific or technical character. If exclusively popular, they simply become magazines or journals, which it is not the province of the Government to provide, while if they seek to combine popular and scientific matter, there must be a great waste of material somewhere in their distribution.

DISTRIBUTION.

In addition to the issue of advance notices of forthcoming publications which are sent to the agricultural papers, so that their readers may have an opportunity to be posted as to the publications of the Department, this division sends out on the first of each month to all the papers, as well as to all individuals applying for it, a list of the publications issued during the month previous. In this connection it

is suggested that whenever application is made, as is so frequently the case, for all the publications of the Department, the applicant's name should be entered to regularly receive this list, with a statement that he must apply specifically for any particular publication he may want.

In the interest of retrenchment it is extremely desirable that, except in the case of bulletins or circulars designed to meet emergencies, general distribution be discouraged, every opportunity being taken to make public the number and character of our publications, in order that those to be benefited may know of them and apply directly for such as they desire to receive.

Of nearly 3,000,000 copies of publications issued by this Department during the past year, exclusive of the reports ordered by Congress, of which only a few are placed at the disposal of the Department for distribution, it is certain that a very large number are wasted in the distribution. That question, however, is beyond the control of this division, and the solution of the difficulty must be ultimately left to others. It is sufficient to say here that the enormous amount of printing devolving upon this Department, in order to make the results of its work available to the public, a duty imposed upon it by the law which created it, and the great increase which has taken place in its publications during the past four or five years, suggest the necessity for the early consideration of some general plan by which the publications of the Department may be more discriminately classified and their distribution so systematized as to prevent waste, and to make every copy of every publication available for some individual or some institution, thus insuring its utilization to the best advantage.

THE EVIL OF UNRESTRICTED FREE DISTRIBUTION.

The vicious principle which seems to be at the root of waste in this matter is general free distribution to practically every applicant until the edition of a work is exhausted, in many cases leaving so many persons still clamoring for it, and many of them able to advance such excellent reasons why they should have it, as to necessitate a reprint. While it is an essential part of the duty of this Department, as already indicated, to publish in some convenient form for the benefit of the public all the information beneficial to agriculture which it is able to gather through the various channels at its disposal, there seems to be no good reason why every such publication should be presented gratuitously to every person applying for it, including that large number of persons who make a practice of applying for anything which can be had for nothing. The time certainly has arrived when, without restricting the exercise by the head of this Department of full discretion as to the best method of publishing and distributing the information at his disposal, he should be authorized to affix a price (in no case exceeding cost of paper, presswork, and binding) to certain publications, limiting the gratuitous distribution to free libraries, to certain agricultural associations, to State departments of agriculture, and to the libraries of such educational institutions as make a specialty of agricultural instruction. Such authorization need in no wise conflict with the full discretion of the Secretary of Agriculture to issue at any time for free distribution bulletins conveying important and practical information which it is desirable to distribute as widely as possible—emergency bulletins as it were—of a character similar to the series now published by the Department under the name of Farmers' Bulletins.

It ought also to be in the power of the Secretary to dispose, through

the Public Printer, of the plates of publications to publishers under suitable conditions as to the price per copy to be charged by them, such sale to confer copyright privileges upon the purchaser. This plan would effectually relieve the public treasury from cost of reprints (of which during the current year there have been 34), and would oftentimes suffice to furnish all needed copies at a moderate price to the public beyond the small number of copies required for gratuitous distribution. The adoption of such plans, or of either of them, would, in my opinion, accomplish far more in the direction of restricting within the limits of reliable economy the publication work of this Department than the provisions of the printing bill now under discussion in Congress, the effect of which, so far as this Department is concerned, is merely to transfer to Congress all power controlling the issue, in editions of over 1,000 copies, of publications containing over 100 octavo pages.

With such provisions for the handling of certain of our publications in a legitimate way by publishers and booksellers, and with certain precautions for the preservation of a certain number of copies of every publication issued by the Department, any improper distribution of publications issued for gratuitous distribution could be effectually prevented by a law making it a misdemeanor for any one to offer or expose for sale such publications, which should bear upon the title-page a statement that they are printed for free distribution, while some indication of this fact should appear on each signature of the work. This restriction on the sale of such publications should not apply after three years from date of issue.

Many objections have been offered by the advocates of an entirely free distribution of public documents to the plan of making a small charge therefor, but none of these objections seem to overweigh the fact that entirely free distribution of all the publications of the Department must inevitably work injustice to some, and these often the most deserving, for the reason that it is utterly impossible with our present population, to say nothing of what it will be in a few years to come, to supply every one who may be benefited; and there is no possibility, even if enough publications should be printed to supply all those who might need them, of discriminating adequately between applicants so as to prevent the supplying of documents in many cases to people who do not need them, and thus cutting off the supply for those who do. As it is, a special provision exists for affixing a price to some of the Department publications, such as those emanating from the Weather Bureau, and, as a matter of fact, subscriptions are received for the Weather Review at the trifling charge of 50 cents a year. Again, a special clause has been introduced into the current act of appropriation for the Department, authorizing the Secretary to charge for the card index of agricultural literature, prepared by the Office of Experiment Stations, a price covering the additional expense involved in the preparation of the copies sold. The only practical solution of the difficulties attending a satisfactory distribution seems to be to give to the head of the Department a general authorization to affix a price to such publications as he thinks proper, not in any case exceeding actual cost of paper, presswork, and binding.

BINDING.

The custom, of long standing in this and other Departments, of binding publications intended for free distribution in cloth or other special binding should certainly be discontinued and paper binding used exclu-

sively for all publications distributed free. It is surely not asking very much of those who receive Government publications free that they should be willing to bind them themselves if they desire to properly preserve them. The cost of extra binding of publications for distribution amounted during the fiscal year 1893 to $9,214.37, or more than 10 per cent of the total amount spent for Department printing during the year.

PRESENT COST OF PRINTING.

The increase in the printing fund of the Department has been great during the past four years. It must be borne in mind, however, first, that there has been a great increase and development in the work of the Department itself and in the number of divisions providing material for the printer. Second, that, in spite of the fact that the work of the Department is designed to directly subserve the interests of nearly one-half the population, to whom the results of its investigations and the information it has collected must be conveyed as promptly and clearly as possible, its appropriation for printing is far less than that of most of the other Departments, only one or two of which are as modestly provided for in this respect as the Department of Agriculture. It is also proper to recall here that, by care and good management, the amount of printing done under the present appropriation of $85,000 per annum has been proportionately very much larger than was the case when the appropriation did not exceed $40,000, having since that time increased nearly fourfold.

While it is essentially desirable that by every means possible strict economy should be enforced in the administration of the printing fund of the Department, and while, since the organization of this division special efforts have been made towards that end and considerable success obtained, it is of the highest importance that we should recognize that the work of publication forms an essential part of the duty of the Department to the public. Under its organic law, the distribution of information is made as much a part of the duty of the head of the Department as the accumulation thereof, whether by investigation, special inquiries, or otherwise. That would therefore not be a measure of true economy consistent with the functions and purposes of the Department which should tend to restrict the distribution of the information it has acquired. It would not be true economy, inasmuch as the large sums expended for investigations and inquiries can be fully justified and full interest thereon realized only by making such information available as soon as possible to all persons who may be benefited by it. It would not be consistent with the purposes of the Department for the reason, already stated, that it is by law as much the duty of the Department to distribute as to acquire information.

The suggestions made in the direction of economy in the present report are directed therefore simply to a judicious expenditure of the printing fund and a prevention of useless distribution. True economy consists in making the most of every dollar expended and the comparison of the printing done in 1889 and that done in 1893 in proportion to the amount of the appropriations for these two years respectively shows that this true economy has prevailed. For this year the total amount of printing done, exclusive of the publications issued as Congressional documents and exclusive of those printed at the Weather Bureau office under the special appropriation for that purpose, fairly represents the results of the expenditure of the $85,000 composing the general printing fund of the Department. The total number of copies included in

this category amounted to 2,689,084, aggregating over 56,000,000 printed pages. Reference has been made to the printing fund of the Department by comparison with that of other Departments. It exceeds but little the printing fund of the Navy Department and, by comparison with the $285,000 assigned to the Treasury, $130,000 to the War Department, and $340,000 to the Interior Department, it is indeed a comparatively insignificant sum.

Reprints.—The total number of reprints included in the aggregate number of publications for the past year is 34, which were issued at a cost of $3,408.75.

The apportionment of the printing fund to the several divisions and branches of the work is shown in the following table:

Statement showing expenditures for printing and binding for the several bureaus and divisions of the U. S. Department of Agriculture for the fiscal year ending June 30, 1893.

From the fund appropriated for the public printing and binding:	
Bureau of Animal Industry	$6,024.14
Weather Bureau	8,529.54
Division of Accounts	257.56
Division of Botany	4,443.23
Division of Chemistry	2,672.76
Division of Entomology	3,143.31
Office of Experiment Stations	9,777.11
Office of Fiber Investigations	1,461.84
Division of Forestry	3,202.80
Division of Gardens and Grounds	211.39
Library	290.37
Division of Microscopy	397.98
Division of Ornithology and Mammalogy	5,447.48
Division of Pomology	770.39
Division of Records and Editing	28.39
Division of Statistics	15,910.94
Seed Division	202.74
Division of Vegetable Pathology	3,519.41
Document and Folding Room	13.68
Miscellaneous	3,562.18
From funds appropriated for the Department:	
Bureau of Animal Industry	12,877.80
Division of Chemistry	1,250.63
Division of Microscopy	575.00
Division of Statistics	238.00
Total	84,808.67

The cost of the blanks and blank books required during the year was $10,762.05 and of binding publications for Department use $4,498.66. Of the amount charged against the Weather Bureau, nearly all was expended for the blank forms found necessary in its work, the Bureau having been able, by utilizing its own printing equipment, to print nearly all of its publications.

PUBLICATIONS OF THE YEAR.

A full list of the publications of the Department for the year is appended, as usual.

OFFICE OF THE SECRETARY.

	Copies.
Report of the Secretary of Agriculture for 1892. Pp. 656, illustrated. August, 1893	500,000
Report of the Secretary of Agriculture for 1893. (Preliminary report to the President.) Pp. 48. November, 1893	20,000
Special report of the Assistant Secretary of Agriculture for 1892. Duties of the Assistant Secretary; Review of the Work, 1889-'92. (From the Report of the Secretary of Agriculture for 1892.) Pp. 67-84. June, 1893	500

	Copies.
Progress Report on the Dairy Industry of Denmark. Pp. 14. March, 1893	2,000
Indian Corn (or Maize) in the Manufacture of Beer. Pp. 21. September, 1893	3,500
German edition, pp. 22. September, 1893	3,000
Report on the Use of Indian Corn in Europe (Scandinavian edition). Pp. 22. February, 1893	2,500
Farmers' Bulletin No. 7. Spraying Fruits for Insect Pests and Fungous Diseases, with a Special Consideration of the Subject in its Relation to the Public Health. Pp. 20. (Reprint.)	10,000
Studies of Parasitic and Predaceous Insects in New Zealand, Australia, and Adjacent Islands. Made by A. Koebele, at the request of the California State Board of Horticulture. Pp. 39. June, 1893	1,500
Preliminary Report of the Secretary of Agriculture for 1890. Pp. 52. (Reprint.)	250
Preliminary Report of the Secretary of Agriculture for 1891. Pp. 59. (Reprint.)	250
Selected Correspondence relating to the Export Trade of the United States in Live Stock and Meat Products. Pp. 33. March, 1893	300
Special Report on Tea-Raising in South Carolina. (From the Report of the Secretary of Agriculture for 1892.) Pp. 627-640, pls. 3. July, 1893	500
Letter from the Secretary of Agriculture, transmitting the Report of the Bureau of Animal Industry for the year 1892. (Senate Ex. Doc. No. 20, Fifty-second Congress, second session.) Pp. 229. January, 1893	**1,734**
Letter from the Secretary of Agriculture, transmitting a statement showing the expenditure of the appropriation for experiments in the manufacture of sugar. (House Executive Document No. 251, Fifty-second Congress, second session.) Pp. 3. March, 1893	**1,734**

BUREAU OF ANIMAL INDUSTRY.

Eighth and Ninth Annual Reports of the Bureau of Animal Industry, for the Years 1891 and 1892. Pp. 428, pls. 11, figs. 7. October, 1893	50,000
Bulletin No. 1, Bureau of Animal Industry. Investigations into the Nature, Causation, and Prevention of Texas or Southern Cattle Fever. Pp. 301, pls. 10, figs. 7. March, 1893	10,000
Bulletin No. 2, Bureau of Animal Industry. Report upon Investigations Relating to the Treatment of Lumpy-jaw, or Actinomycosis, in Cattle. Pp. 90, pls. 8. February, 1893	10,000
Bulletin No. 3, Bureau of Animal Industry. Special Report on Miscellaneous Investigations Concerning Infectious and Parasitic Diseases of Domesticated Animals. Pp. 88, pls. 3. November, 1893	3,000
Map showing the boundary line of the district infected with splenetic or Southern fever of cattle. Size, 17 by 36 inches. March 6, 1893	3,000
Report of the Chief of the Bureau of Animal Industry for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 85-122. June, 1893	500

DIVISION OF BOTANY.

Botanical Bulletin No. 13. Grasses of the Pacific Slope, Including Alaska and the Adjacent Islands. Plates and Descriptions (50) of the Grasses of California, Oregon, Washington, and the Northwestern Coast, including Alaska. Part II. Size, 7½ by 11½ inches. May, 1893	5,000
Contributions from the U. S. National Herbarium, Vol. I, No. 7. Systematic and Alphabetic Index to New Species of North American Phanerogams and Pteridophytes published in 1892. Pp. III, 233-263, III. July, 1893	2,500
Contributions from the U. S. National Herbarium, Vol. I, No. 8. Notes on Some Pacific Coast Grasses; Descriptions of New or Noteworthy Grasses from the United States; Descriptions of New Grasses from Mexico; Description of New Plants from Texas and Colorado; List of Plants new to Florida; Descriptions of three New Plants; Lists of Lichens from California and Mexico, collected by Dr. Edward Palmer from 1888 to 1892. Pp. III, 265-292, II, pls. 19-23, October, 1893	2,500
Contributions from the U. S. National Herbarium, Vol. IV. Botany of the Death Valley Expedition. A Report on the Botany of the Expedition sent out in 1891, by the U. S. Department of Agriculture, to make a Biological survey of the Region of Death Valley, California. Pp. VIII, 361, pls. 21, 1 map. November, 1893	4,000

	Copies.
Farmers' Bulletin No. 10. The Russian Thistle and Other Troublesome Weeds in the Wheat Region of Minnesota and North and South Dakota. Pp. 16. March, 1893	5,000
Report of the Botanist for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 201-214. June, 1893	500

DIVISION OF CHEMISTRY.

Chemical Bulletin No. 13, part 8. Food and Food Adulterants—Canned Vegetables. Pp. 1015-1167. August, 1893	10,000
Chemical Bulletin No. 32. Special Report on the Extent and Character of Food Adulterations, including State and other Laws Relating to Foods and Beverages. Pp. 174. (Reprint.)	1,000
Chemical Bulletin No. 36. Experiments with Sugar Beets in 1892. Pp. 74. March, 1893	5,000
Chemical Bulletin No. 37. Record of Experiments with Sorghum in 1892. Pp. 100. April, 1893	5,000
Chemical Bulletin No. 38. Proceedings of the Tenth Annual Convention of the Association of Official Agricultural Chemists, held at Chicago, Ill., August 24, 25, and 26, 1893. Pp. 218. December, 1893	3,500
Farmers' Bulletin No. 3. Culture of the Sugar Beet. Pp. 24, figs. 9. (Reprint.)	10,000
Farmers' Bulletin No. 12. Nostrums for Increasing the Yield of Butter. Pp. 16. June, 1893	25,000
Report of the Chief of the Division of Chemistry for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 123-152. June, 1893.	500

DIVISION OF ENTOMOLOGY.

Entomological Bulletin No. 25. Destructive Locusts: A Popular Consideration of a Few of the More Injurious Locusts (or "Grasshoppers") of the United States, together with the Best Means of Destroying Them. Pp. 62, pls. 12, figs. 11, 1 map. (Reprint.)	5,000
Entomological Bulletin No. 28. The More Destructive Locusts of America North of Mexico. Pp. 40. April, 1893	5,000
Entomological Bulletin No. 29. Report on the Boll Worm of Cotton. Pp. 73, pls. 2. May, 1893	5,000
Entomological Bulletin No. 30. Reports of Observations and Experiments in the Practical Work of the Division, Made under the Direction of the Entomologist. Pp. 67. June, 1893	2,500
Entomological Bulletin No. 31. Catalogue of the Exhibit of Economic Entomology at the World's Columbian Exposition, Chicago, Ill., 1893, Made under the Direction of the Entomologist. Pp. 121. August, 1893	3,000
Insect Life. (Devoted to the economy and life habits of insects, especially in their relations to agriculture, and edited by the Entomologist and his assistants.)	
Vol. V, No. 3. Pp. III, 147-212, figs. 10-22. January, 1893	5,500
Vol. V, No. 4. Pp. III, 213-288, pl. 1, figs. 23-37. May, 1893	5,500
Vol. V, No. 5. Pp. III, 289-402, pls. 2, 3, figs. 38-47, with index and contents (pp. VII) to Vol. V. August, 1893	5,500
Vol. VI, No. 1. Pp. III, 58, fig. 1. November, 1893	5,500
Vol. VI, No. 2. Pp. III, 59-206, figs. 2-5. December, 1893	5,600
Report of the Entomologist for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. III, 153-180, II, pls. 12. July, 1893	500

OFFICE OF EXPERIMENT STATIONS.

Experiment Station Bulletin No. 13. Organization Lists of the Agricultural Experiment Stations and Agricultural Schools and Colleges in the United States. Pp. 123. June, 1893	3,000
Experiment Station Bulletin No. 14. Proceedings of a Convention of the National League for Good Roads, held at Washington, D. C., January 17 and 18, 1893, and Hearing by the Committee on Agriculture of the House of Representatives, January 19, 1893. Pp. 101. July, 1893	18,000
Experiment Station Bulletin No. 15. Handbook of Experiment Station Work. A Popular Digest of the Publications of the Agricultural Experiment Stations in the United States. Pp. 411. December, 1893	3,000
Experiment Station Bulletin No. 16. Proceedings of the Sixth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations held at New Orleans, La., November 15-19, 1892. Pp. 176. September, 1893	4,000

Copies.

Experiment Station Bulletin No. 17. Suggestions for the Establishment of Food Laboratories in Connection with the Agricultural Experiment Stations of the United States. Pp. 20. October, 1893 3,000

Experiment Station Record. (A condensed record of the contents of the bulletins and reports issued by the Agricultural Experiment Stations in the United States.)

Vol. IV, No. 6. Pp. VI, 455–524. February, 1893 6,000
Vol. IV, No. 7. Pp. VI, 525–624. May, 1893 6,000
Vol. IV, No. 8. Pp. VI, 625–700. June, 1893 6,000
Vol. IV, No. 9. Pp. VII, 701–790. August, 1893 6,000
Vol. IV, No. 10. Pp. VII, 791–878. August, 1893 6,000
Vol. IV, No. 11. Pp. VII, 879–994. September, 1893 6,000
Vol. IV, No. 12 (index). Pp. 995–1086, XXX. December, 1893 6,000
Vol. V, No. 1. Pp. VIII, 138. December, 1893 8,000

Farmers' Bulletin No. 11. The Rape Plant: Its History, Culture, and Uses. Pp. 20, figs. 4. June, 1893 15,000

Circular No. 23 of the Office of Experiment Stations. Key to Subject Index of Literature of Agricultural Experiment Stations and Kindred Institutions. Pp. 3. December, 1893 500

Circular No. 24 of the Office of Experiment Stations. Address List of the Agricultural Experiment Stations. P. 1. December, 1893 500

Report of the Director of the Office of Experiment Stations for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 515–549. June, 1893 500

OFFICE OF FIBER INVESTIGATIONS.

Fiber Report No. 2. Recent Facts regarding the Ramie Industry in America. Pp. 16. (Reprint.) 1,000

Fiber Report No. 5. A Report on The Leaf Fibers of the United States, detailing Results of Recent Investigations Relating to Florida Sisal Hemp, the False Sisal Hemp Plant of Florida, and other Fiber-producing Agaves; Bow-string Hemp, Pineapple Fiber, New Zealand Flax, and Bear grass. Pp. 73, pls. 10, figs. 12. July, 1893 8,000

Report of the Special Agent in charge of Fiber Investigations for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 359–376, pls. 6, figs. 4. June, 1893 500

DIVISION OF FORESTRY.

Forestry Bulletin No. 7. Forest Influences. (Contents: Introduction and Summary of Conclusions; Review of Forest Meteorological Observations; Relation of Forests to Water Supplies; Notes on the Sanitary Significance of Forests; Determination of the True Amount of Precipitation and its Bearing on Theories of Forest Influences; Analysis of Rainfall with Relation to Surface Conditions.) Pp. 197, figs. 63. June, 1893 9,750

Forestry Bulletin No. 8. Timber Physics, Part 2: Progress Report. Results of Investigations on Long-leaf Pine (*Pinus palustris*). (Contents: Mechanical Tests made at Washington University Testing Laboratory, St. Louis, Mo.; The Long-leaf Pine, its Characteristics and Distribution; Results of Mechanical Tests; Field Report on Turpentine Timber; Resinous Contents and their Distribution in the Long-leaf Pine; Field Records of Test Materials.) Quarto. Pp. VII, 92, pls. 12, figs. 22. June, 1893 5,000

Circular No. 9 of the Division of Forestry. Effect of Turpentine Gathering on the Timber of Long-leaf Pine. P. 1, January, 1893 5,000

Circular No. 10 of the Division of Forestry. Suggestions to the Lumbermen of the United States in behalf of More Rational Forest Management. Pp. 8. April, 1893 15,000

Letter to the Secretary of Agriculture regarding Forest Growth and Timber Consumption. By B. E. Fernow. Pp. 3. April, 1893 200

Report of the Chief of the Division of Forestry for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. III, 293–358, pls. 6, diagram 1. July, 1893 10,000

DIVISION OF GARDENS AND GROUNDS.

Papers on Horticultural and Kindred Subjects. Pp. 124. (Reprint.) 3,000

Report of the Superintendent of Gardens and Grounds for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. III, 377–402. June, 1893 500

OFFICE OF IRRIGATION INQUIRY.

	Copies.
Bulletin No. 1 of the Office of Irrigation Inquiry. Abstract of the Laws of the Several States and Territories on Irrigation and Water Rights. Pp. 180. September, 1893	2,500

DIVISION OF MICROSCOPY.

Report of the Microscopist for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 281-292, pls. 9. June, 1893	10,000

DIVISION OF ORNITHOLOGY AND MAMMALOGY.

Ornithological Bulletin No. 3. The Hawks and Owls of the United States. Pp. 210, pls. 26. February, 1893	5,000
Ornithological Bulletin No. 4. The Prairie Ground Squirrels or Spermophiles of the Mississippi Valley. Pp. 69, pls. 3. October, 1893	5,000
North American Fauna No. 7. The Death Valley Expedition: A Biological Survey of Parts of California, Nevada, Arizona, and Utah. Part 2. (Reports on Birds, Reptiles, and Batrachians, Fishes, Insects, Mollusks, Desert Trees, and Shrubs, Desert Cactuses, and Yuccas, and List of Localities of the Region Traversed.) Pp. 384, pls. 14, maps 5. May, 1893	4,850
Report on the Ornithology of the Death Valley Expedition of 1891, Comprising Notes on the Birds Observed in Southern California, Southern Nevada, and Parts of Arizona and Utah. (From North American Fauna No. 7.) Pp. 7-158, 1 map. July, 1893	150
Annotated List of the Reptiles and Batrachians Collected by the Death Valley Expedition in 1891, with Descriptions of New Species. (From North America Fauna No. 7.) Pp. 159-228, pls. 4. July, 1893	150
Report on the Fishes of the Death Valley Expedition, Collected in Southern California and Nevada in 1891, with Descriptions of New Species. (From North American Fauna No. 7.) Pp. 229-234, pls. 5, 6. July, 1893	150
Report on a Small Collection of Insects made during the Death Valley Expedition; List of Diptera from Death Valley, California, and Adjoining Regions; Hemiptera and Heteroptera of the Death Valley Expedition. (From North American Fauna No. 7.) Pp. 235-268. July, 1893	150
Report on the Land and Fresh-water Shells Collected in California and Nevada by the Death Valley Expedition, Including a few Additional Species Obtained by Dr. C. Hart Merriam and Assistants in parts of the Southwestern United States. (From North American Fauna No. 7.) Pp. 269-283. July, 1893	150
Notes on the Distribution of Trees and Shrubs in the Deserts and Desert Ranges of Southern California, Southern Nevada, Northwestern Arizona, and Southwestern Utah; Notes on the Geographic and Vertical Distribution of Cactuses, Yuccas, and Agave, in the Deserts and Desert Ranges of Southern California, Southern Nevada, Northwestern Arizona, and Southwestern Utah. (From North American Fauna No. 7.) Pp. 285-359, pls. 9, maps 4. July, 1893	150
List of Localities in California, Nevada, and Utah Visited by the Death Valley Expedition of 1891. (From North American Fauna No. 7.) Pp. 361-384, 1 map. July, 1893	150
Report of the Ornithologist and Mammalogist for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 181-200, pls. 5. August, 1893	500

DIVISION OF POMOLOGY.

Report of the Pomologist for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 247-280, pls. 13. June, 1893	10,000

DIVISION OF RECORDS AND EDITING.

Report of the Chief of the Division of Records and Editing for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 497-508. June, 1893	500

DIVISION OF STATISTICS.

Report No. 5, Miscellaneous Series. Production and Distribution of the Principal Agricultural Products of the World. Pp. 205. March, 1893	10,000
Report No. 6, Miscellaneous Series. Rice: Its Cultivation, Production, and Distribution in the United States and Foreign Countries, with a Chapter on the Rice Soils of South Carolina. Pp. 89. April, 1893	5,000

	Copies.
Report No. 7, Miscellaneous Series. An Agricultural Survey of Wyoming. Pp. 72, 1 map. May, 1893	8,000
Statistical Report No. 101. Report of the Statistician, January and February, 1893. Contents: Agriculture in France; Report on Hungarian Milling; The Canning Industry; Tobacco Experiments in Texas; European Crop Report for February; Farm Animals of the World; Transportation Rates. Pp. 71. [February, 1893.]	20,000
Report upon the Numbers and Values of Farm Animals, and on Cotton Distribution. Pp. 20. February, 1893	20,000
Report on Distribution and Consumption of Corn and Wheat. Pp. 16. March, 1893	20,000
Statistical Report No. 102. Report of the Statistician, March, 1893. Contents: Agriculture in Alaska; Foreign Official Crop Estimates; European Crop Report; Wheat Crop of the World; Transportation Rates. Pp. 71–95.	20,000
Statistical Report No. 103. Report of the Statistician, April, 1893. Contents: Condition of Winter Grain; Notes concerning wheat from reports of State agents and county correspondents; Condition of Farm Animals; European Crop Report; Transportation Rates. Pp. 97–140	20,000
Statistical Report No. 104. Report of the Statistician, May, 1893. Contents: Condition of Winter Grain; Mowing Lands and Pastures; Progress of Cotton Planting; Spring Plowing; Changes in Crop Areas; Temperature and Rainfall; Notes from Reports of State Agents; The Cotton Crop of India for the Year 1892–'93; European Crop Report for May, 1893; Transportation Rates. Pp. 141–178	20,000
Statistical Report No. 105. Report of the Statistician, June, 1893. Contents: Crop Report for June; Agriculture in the Caucasus; The Customs Tariff in Martinique; Agricultural Produce Statistics of the United Kingdom; Transportation Rates. Pp. 179–221	20,000
Statistical Report No. 106. Report of the Statistician, July, 1893. Contents: Crop Report for July; Statistics of Ontario; Foreign Import Duties on Wheat; Notes on Foreign Agriculture; Use of Maize of the United States in Mexico; Transportation Rates. Pp. 223–270	20,000
Statistical Report No. 107. Report of the Statistician, August, 1893. Contents: Crop Report for August; Notes on Foreign Agriculture; Wheat Crop of India for 1893; Production of Corn in New South Wales; Domestic and Transatlantic Freight Rates. Pp. 271–322	20,000
Statistical Report No. 108. Report of the Statistician, September, 1893. Contents: September Crop Report; Agricultural Returns of Great Britain; Ontario Crop Report; Crops in Germany; Notes from United States Consular Officers in Scotland, France, Germany, Belgium, Cochin-China, and Ontario; Domestic and Transatlantic Freight Rates. Pp. 323–369	20,000
Statistical Report No. 109. Report of the Statistician, October, 1893. Contents: October Crop Report; Notes from Reports of State Agents; Imports of Hay into the United Kingdom; Cereal Crops of France and Italy for 1893; Citrus Fruit Crop in Italy for 1892–'93; Production, Commerce, and Consumption of Wine in Italy; Corn as Feed for Horses in Germany; Reports from Consular Officers relating to crops in Germany, Scotland, New Brunswick, and Ontario; Domestic and Transatlantic Freight Rates. Pp. 371–414	20,000
Statistical Report No. 110. Report of the Statistician, November, 1893. Contents: November Crop Report; Notes from Reports of State Agents; Imports of American Wheat Flour into Europe; the Hop Crop of England for 1893; the Beet-Sugar Production of Europe for the Year 1893–'94; Agriculture in Great Britain and Ireland; Notes from U. S. Consular Officers regarding crops in Ontario, Spain, Cochin-China, Korea, Scotland, and Egypt; Domestic and Transatlantic Freight Rates. Pp. 415–458	18,000
Monthly Crop Synopsis. (A four-page summary of the condition, prospects, yields, price, distribution, and consumption of crops, and the number and value of farm animals. Issued soon after the 10th of each month for prompt and wide circulation in advance of the more extended monthly crop report from which it is condensed.)	
January Synopsis. (From December Crop Report)	122,500
February Synopsis. (From Statistical Report No. 101)	122,500
March Synopsis. (From Statistical Report No. 102)	122,500
April Synopsis. (From Statiscal Report No. 103)	122,500
May Synopsis. (From Statistical Report No. 104)	122,700
June Synopsis. (From Statistical Report No. 105)	122,700
July Synopsis. (From Statistical Report No. 106)	123,700
August Synopsis. (From Statistical Report No. 107)	122,700
September Synopsis. (From Statistical Report No. 108)	126,700

Monthly Crop Synopsis—Continued. Copies.

October Synopsis. (From Statistical Report No. 109) 126,700
November Synopsis. (From Statistical Report No. 110) 126,700
December Synopsis. (From Statistical Report No. 111) 126,700

Report of the Statistician for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 403-470. June, 1893 500

DIVISION OF VEGETABLE PATHOLOGY.

Bulletin No. 4 of the Division of Vegetable Pathology. Experiments with Fertilizers for the Prevention and Cure of Peach Yellows, 1889-1892. Pp. 197, pls. 33. July, 1893 5,000

Journal of Mycology. (Devoted to the study of fungi, especially in their relations to plant diseases. With illustrations.)

Vol. VII, No. 3. Pp. v, 195-331, pls. 18-31, figs. 3, diagrams 2, chart 1. June, 1893 2,500

Experiments in Preventing Leaf Diseases of Nursery Stock in Western New York. (From the Journal of Mycology, Vol. VII, No. 3.) Pp. 240-264, pls. 21-29, diagrams 2. July, 1893 500

Circular No. 13 of the Division of Vegetable Pathology. Circular of inquiry relative to "Leaf Curl" of peach trees. Pp. 3, letter size. December, 1893 3,000

Report of the Chief of the Division of Vegetable Pathology for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. 215-246, pls. 4. July, 1893 500

WEATHER BUREAU.

Weather Bureau Bulletin No. 7. Report of the First Annual Meeting of the American Association of State Weather Services Coöperating with the Weather Bureau, U. S. Department of Agriculture. Pp. 49, figs. 6. February, 1893 6,500

Weather Bureau Bulletin No. 8. Report on the Climatology of the Cotton Plant. Pp. 68, charts 7. April, 1893 7,500

Weather Bureau Bulletin No. 9. Report on the Forecasting of Thunderstorms during the Summer of 1892. Pp. 54, charts 6. July, 1893 7,500

Weather Bureau Bulletin No. 10. The Climate of Chicago. Pp. 137, figs. 26. August, 1893 5,000

Bulletin A of the Weather Bureau. Summary of International Meteorological Observations. Size, 19 by 24 inches. Pp. 10, charts 61. August, 1893. 500

Monthly Weather Review. (A summary by months of weather conditions throughout the United States, based upon reports of nearly 3,000 regular and voluntary observers. Size, quarto.)

Vol. XX, No. 11, November, 1892. Pp. 289-318, charts 6 3,455
Vol. XX, No. 12, December, 1892. Pp. 319-346, charts 7 3,500
Vol. XX, Supplement to No. 12. (Annual summary for 1892.) Pp. 347-362, charts 7 3,525
Vol. XXI, No. 1, January, 1893. Pp. 30, charts 9 3,610
Vol. XXI, No. 2, February, 1893. Pp. 31-60, charts 8 3,635
Vol. XXI, No. 3, March, 1893. Pp. 61-90, charts 6 3,635
Vol. XXI, No. 4, April, 1893. Pp. 91-122, charts 6 3,680
Vol. XXI, No. 5, May, 1893. Pp. 123-152, charts 6 3,680
Vol. XXI, No. 6, June, 1893. Pp. 153-178, charts 5 3,680
Vol. XXI, No. 7, July, 1893. Pp. 179-204, charts 5 3,680
Vol. XXI, No. 8, August, 1893. Pp. 205-240, charts 5 4,188
Vol. XXI, No. 9, September, 1893. Pp. 241-267, charts 6 3,731
Vol. XXI, No. 10, October, 1893. Pp. 268-308, charts 6 3,825

Report of the Chief of the Weather Bureau, 1891-'92. (Devoted chiefly to tables recording climatological data for the years 1891 and 1892.) Quarto, pp. 528, pls. 4, figs. 23. December, 1893 8,000

Parts I to VI, inclusive, of the Report of the Chief of the Weather Bureau, 1891-'92, printed separately. Quarto.

Part I. Contents: Introduction, List of Observing Stations, Description of Instruments, and Instrumental Corrections—Methods of Reduction. Pp. 7-48, figs. 22. December, 1893 1,000

Part II. Contents: Hourly Averages of Atmospheric Pressure, Temperature, and Wind from the Records of Self-recording Instruments at Twenty-eight Stations. Pp. 49-139. December, 1893 1,000

Part III. Contents: Monthly and Annual Meteorological Summaries for Weather Bureau Stations. Pp. 141-303. December, 1893 1,000

Part IV. Contents: Monthly and Annual Mean Temperature and Annual Extremes of Temperature, together with the Dates of First and Last Killing Frost. Pp. 305-365. December, 1893 1,000

	Copies.
Parts I to VI, inclusive, of Report of Chief of Weather Bureau, etc.—Cont'd.	
Part V. Contents: Monthly and Annual Precipitation—All Stations. Pp. 307–433. December, 1893	1,000
Part VI. Contents: Miscellaneous Meteorological Tables and Reports. Pp. 435–528, pls. 4, fig. 22. December, 1893	1,000
Report of the Chief of the Weather Bureau for 1892. (From the Report of the Secretary of Agriculture for 1892.) Pp. IV, 551–626, II, pls. 4. July, 1893	9,000
Certain Climatic Conditions of the Two Dakotas. Size, 9¼ by 11¾ inches, with maps, charts, and appendixes. Pp. 206. June, 1893	2,000
Anemometry. A circular of general information respecting the theory and operation of typical instruments for indicating, measuring, and automatically recording wind movement and direction, with detailed instructions for the erection and care of those instruments of the Weather Bureau pattern. Circular D, Instrument Room. Pp. 40, figs. 18. March, 1893	1,000
Instructions for Using Marvin's Weighing Rain and Snow Gauge. Circular E, Instrument Room. Pp. 16, figs. 5. October, 1893	500
Instructions for using Glass Electrical Sunshine Recorder. Pattern, 1893. Size, 6 by 9½ inches. Pp. 4, figs. 2. June, 1893	200
Instructions to Special Rainfall Observers of the Weather Bureau. Pp. 22. November, 1893	300
Daily River Stages at River-gauge Stations on the Principal Rivers of the United States for the years 1890, 1891, 1892. Size, 8½ by 10 inches. Pp. LXVII, 439, charts 12. May, 1893	60
Description of River Gauges, Bench Marks, Danger Lines, Low Water and Flood Marks at United States Weather Bureau River Stations. (From Daily River Stages at River-gauge Stations on the principal Rivers of the United States for the years 1890, 1891, 1892.) Pp. LXVII. Size, 8½ by 10 inches. May, 1893	300
Rainfall Laws, Deduced from Twenty Years of Observation. Pp. 94, figs. 16. December, 1893	100
Weather Map. (Issued twice daily, showing weather conditions throughout the United States, and furnishing forecasts of probable changes.)	
Edition published at Washington, D. C. Size, 19 by 24 inches. Average daily issue	700
Editions published at various stations of the Weather Bureau outside of Washington, D. C. Size, 13½ by 22½ inches. Average daily issue.	9,562
Weather Crop Bulletin. (A brief summary of the condition of weather and crops of the United States, showing by maps and tables the departures from normal temperature and rainfall for the period covered by the bulletin. Issued weekly from April to October, inclusive, a separate monthly edition being continued throughout the year, and all issues being numbered consecutively in the order of their appearance. Uniform with weather map in size and form.) Nos. 1 to 32. Average number of each issue	2,700
Daily Bulletin. (Issued at Weather Bureau stations outside of Washington, D. C., showing the weather conditions at selected stations of the Bureau, the data being telegraphed to the various observers, who enter the same and cause the bulletins to be displayed, as in the case of the weather maps.) Size, 8 by 10 inches and 10 by 16 inches. Average daily issue	2,710
Lake Storm Bulletin. (Issued whenever severe storms pass across the region of the Great Lakes during the season of navigation, and furnished for distribution to observers at all Weather Bureau stations on the lakes.)	
No. 1. Storm of October 4 to October 7, inclusive. Size, 19 by 20 inches. October 7, 1893	775
No. 2. Storm of October 5 to October 14, inclusive. Size, 19 by 20 inches. October 17, 1893	1,000
No. 3. Storm of November 16 and 17. Size, 19 by 24 inches. November 18, 1893	980
No. 4. Storm of November 20 to November 23, inclusive. Size, 19 by 24 inches. November 23, 1893	1,000
No. 5. Storm of December 14 to December 16, inclusive. Size, 19 by 24. December 16, 1893	1,000
Current Chart of the Great Lakes. Size, 24 by 33 inches. October, 1893	5,000
Snow Chart. (Issued weekly during the season, showing depth of snow on ground and ice in rivers and harbors.) Size, 19 by 23½ inches. Fifteen of these charts were issued during the year. Total number	5,824
The Development and Movement of Cyclones, as shown in the morning and evening weather maps, April 2–6, 1892. Size, 11¼ by 14 inches. Charts 9. September, 1893	1,100

REPORT OF THE SUPERINTENDENT OF THE DOCUMENT AND FOLDING ROOM.

SIR: I have the honor to submit herewith my report on the work of the Document and Folding Room for the year 1893.

Very respectfully,

WILL H. BANE,
Superintendent.

Hon. J. STERLING MORTON,
Secretary.

On assuming charge of this division, July 12, 1893, it was at once apparent that a thorough reorganization of the work was greatly to be desired, indeed, imperatively necessary. This task was at once undertaken, and, thanks to a previous long experience in this class of work, it is believed to have been effected on the right lines.

The assistants in the division were performing their duties under many disadvantages as the result of not having their work systematized. It was easy to see that with a well-defined and properly executed plan the force could accomplish nearly three times the amount of work. The success attained by the methods at once adopted is the strongest evidence that the pressing need of the division was a better system, in order to facilitate the handling of the enormous quantity of documents issued by the Department.

The clerks and folders are now better trained to their respective duties, and the result is that the division is at present handling 50 per cent more mail than ever before in its history, and doing it with the same force, while the labor of each employee is not perceptibly increased.

The large number of publications handled by this division necessitated the placing of one of the clerks in charge of the stock rooms, and a system of checking has been adopted in accordance with which no book can be mailed either to parties on a permanent list or a single copy order without a voucher or request being duly entered on the stock book. This clerk by reference to his stock book can give accurately the number of volumes on hand and at the same time by a system recently devised avoid the danger of duplicating orders. The mailing lists are growing daily and call for careful attention at all times.

Aside from the addressed franks received from the different divisions of the Department the number of franks written in the Folding Room during the past year reached the unprecedented figure of 900,000. In addition to these there were also addressed and mailed to correspondents supplies aggregating 200,000 letter sheets and circulars and 500,000 envelopes.

The advance notices compiled and prepared by the Division of Records and Editing and mailed by this division have amounted to 200,000, and the number of letters and postals has aggregated 14,000.

The practice has been adopted of sending a return postal card with each publication mailed from the division, requesting the recipient to acknowledge same and return to the Department. This, of course, involves a great amount of work, but so far it has been handled without extra addition to the force, which is capable of and doing efficient work most expeditiously and in a manner highly satisfactory to the patrons of this division and to its superintendent.

It is proper that your attention should be called to the inadequate facilities for storing and handling the large number of publications received at this division. More room is needed to store all the publications so that they may be so conveniently placed as to facilitate their being handled properly and promptly in the preparation for mailing. Again, it is absolutely essential that something should be done to remedy the inflammable character of the building now occupied by this division. Considering the great number of valuable publications and documents that are stored in this building and the combustible material which occupies another portion of the same structure it is indeed marvelous that a disastrous conflagration has not already swept the publications of the Department out of existence.

REPORT OF THE CHIEF OF THE DIVISION OF ACCOUNTS AND DISBURSEMENTS.

SIR: I have the honor to present herewith a report showing, in a condensed form, the work of the Division of Accounts and Disbursements during the year 1893.

Very respectfully,

F. L. EVANS,
Chief.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE YEAR.

The statements of appropriations and disbursements presented in this report are necessarily for the fiscal year 1893. During this period disbursements were made aggregating $2,350,879.80. This amount appears in detail in the following table, together with the sums appropriated for the preceding fiscal year, and amounts unexpended on each, including supplemental account, and representing practically all payments to be made on a majority of the appropriations.

Statement showing appropriations for the fiscal year 1893, amount disbursed during the year, and the unexpended balance covered into the Treasury.

Object of appropriation.	Amount appropriated.	Amount disbursed.	Amount unexpended.
Salaries, Department of Agriculture	$256,800.00	$253,896.30	$2,903.70
Collecting agricultural statistics	100,000.00	87,879.48	12,120.52
Investigating foreign demands for United States agricultural products	10,000.00	7,546.86	2,453.14
Botanical investigations and experiments	27,500.00	27,448.37	51.63
Investigating the history and habits of insects	17,800.00	17,290.80	509.20
Investigations in ornithology and mammalogy	15,000.00	14,947.77	52.23
Pomological information	5,000.00	4,745.94	254.06
Microscopical investigations	2,000.00	1,982.98	17.02
Vegetable pathological investigations and experiments	20,000.00	19,976.92	23.08
Laboratory	6,900.00	6,900.00	....
Adulteration of food	12,500.00	9,853.50	2,646.50
Fiber investigations	5,000.00	4,997.07	2.93
Report on forestry	12,000.00	11,933.39	66.61
Illustrations and engravings	2,000.00	1,906.73	93.27
Purchase and distribution of valuable seeds	130,000.00	129,637.01	362.99
Printing, labor, material, etc	5,400.00	5,280.86	119.14
Document and Folding Room	2,000.00	1,623.55	376.45
Experimental gardens and grounds	28,500.00	28,115.09	384.91
Museum	4,000.00	3,973.67	26.33
Furniture, cases, and repairs	10,000.00	8,740.60	1,259.40
Library	3,000.00	2,517.65	482.35
Postage	5,000.00	3,705.00	1,295.00

Statement showing appropriations for the fiscal year 1893, etc.—Continued.

Object of appropriation.	Amount appropriated.	Amount disbursed.	Amount unexpended.
Contingent expenses	$25,000.00	$22,396.54	$2,603.46
Quarantine stations for neat cattle	15,000.00	12,574.73	2,425.27
Agricultural experiment stations	20,000.00	18,790.15	1,209.85
Experiments in the manufacture of sugar	20,000.00	19,978.38	21.62
Irrigation investigations	6,000.00	4,930.67	1,069.33
Experiments in the production of rainfall	10,000.00	4,913.59	5,086.41
Bureau of Animal Industry	850,000.00	724,213.18	125,786.82
Total	1,626,400.00	1,462,696.78	163,703.22
Weather Bureau:			
Salaries	176,395.22	172,876.68	3,518.54
Fuel, lights, and repairs	9,700.00	8,451.53	1,248.47
Contingent expenses	13,700.00	11,857.46	1,842.54
General expenses	368,965.50	355,516.72	13,448.78
General expenses, salaries	329,900.00	327,822.91	2,077.09
W. B. stations on M. and T. Bay Isles, in Lake Huron	15,000.00	11,657.72	3,342.28
Total—Weather Bureau	913,660.72	888,183.02	25,477.70
Grand total for the Department	2,540,060.72	2,350,879.80	189,180.92

An itemized statement of these expenditures has recently been made to Congress, ordered to be printed, and will shortly appear in pamphlet form for distribution.

During the fiscal year the Division of Accounts audited and paid 14,344 accounts. There were drawn in settlement thereof 22,895 checks, involving $2,350,879.80. Of the gross amount paid about $1,725,000 was for compensation, the remainder covering an infinite variety of payments, in sums varying from a few cents to thousands of dollars.

Disbursements have been made from the appropriations for the current fiscal year to December 1, 1893, amounting to $682,289.94. Comparing these amounts in detail with the expenditures during the same period of last year, i. e., July 1 to December 1, 1892, we have the following table showing a decreased monthly expenditure of $20,190.69:

Comparison of expenditures during the five months, July 1 to December 1, in the years 1892 and 1893.

Object of appropriation.	Dec. 1, 1892.	Dec. 1, 1893.
Salaries, Department of Agriculture	$106,545.63	$96,765.74
Collecting agricultural statistics	29,908.44	29,472.53
Investigating foreign demands for United States agricultural products	1,264.69	2,860.11
Botanical investigations and experiments	12,312.08	10,629.88
Investigating the history and habit of insects	6,487.65	7,385.61
Investigations in ornithology and mammalogy	6,089.26	5,440.35
Pomological information	1,571.65	1,790.85
Microscopical investigations	249.23	388.09
Vegetable pathological investigations and experiments	7,593.11	5,330.32
Laboratory	4,028.93	1,394.43
Adulteration of food	2,275.08	2,928.31
Fiber investigations	3,022.81	1,090.76
Report on forestry	5,614.17	5,788.04
Illustrations and engravings	419.66	153.40
Purchase and distribution of valuable seeds	39,620.76	51,434.53
Printing, labor, material, etc	2,299.55	1,918.40
Document and Folding Room	702.93	1,396.48
Experimental gardens and grounds	14,902.60	11,980.34
Museum	1,466.44	924.56
Furniture, cases, and repairs	4,305.97	2,558.39
Library	939.84	1,066.27
Postage	915.00	865.00
Contingent expenses	8,502.38	6,713.49
Quarantine stations for neat cattle	4,415.03	2,006.43
Agricultural experiment stations	6,897.86	7,709.80
Experiments in the manufacture of sugar	13,391.93	3,803.36

Comparison of expenditures during the five months, July 1 to December 1, in the years 1892 and 1893—Continued.

Object of appropriation.	Dec. 1, 1892.	Dec. 1, 1893.
Irrigation investigations	$1,560.78	$2,008.10
Experiments in the production of rainfall	3,074 55	....
Inquiries relating to public roads	....	432.46
Bureau of Animal Industry	232,489.45	169,333.34
Total	522,266.89	435,509.37
Weather Bureau:		
Salaries	71,254.82	64,201.67
Fuel, lights, and repairs	3,102.56	2,978.96
Contingent expenses	4,409.80	1,641.54
General expenses	73,010.43	65,875.87
General expenses, salaries	109,129.22	112,082.53
W. B. stations on the M. and T. Bay Isles in Lake Huron	69.67	....
Total Weather Bureau	260,976.50	246,780.57
Grand total for the Department	783,243.39	682,289.94

Below is presented a comparison of the appropriations of the current fiscal year with the estimates of appropriations for the fiscal year ending June 30, 1895. This latter shows a reduction in amount over the appropriations for the current year of $1,089,656.94, which includes $150,000 less in the Bureau of Animal Industry, $100,400 in the Seed Division, and $720,000 in agricultural experiment stations.* Omitting the last item, there remains a reduction of $369,656.94 in favor of the estimates for the coming fiscal year.

Comparison of the appropriations for the fiscal year 1894 with the estimates of appropriations for the fiscal year 1895.

Object of appropriation.	Appropriated for 1894.	Estimated for 1895.
Salaries, Department of Agriculture	$256,800.00	$248,920.00
Furniture, cases, and repairs	10,000.00	10,000.00
Library, Department of Agriculture	3,000.00	6,000.00
Museum, Department of Agriculture	4,000.00	3,000.00
Postage, Department of Agriculture	5,000.00	5,000.00
Contingent expenses, Department of Agriculture	25,000.00	25,000.00
Salaries and expenses, Bureau of Animal industry	850,000.00	700,000.00
Quarantine stations for neat cattle	15,000.00	12,000.00
Collecting agricultural statistics	110,000.00	110,000.00
Purchase and distribution of valuable seeds	130,000.00	30,000.00
Purchase and distribution of valuable seeds, printing, etc	5,400.00	5,000.00
Experimental gardens and grounds	13,000.00	11,000.00
Experimental gardens and grounds, labor, etc	18,500.00	18,500.00
Materials, Document and Folding Room	2,000.00	2,000.00
Illustrations and engravings	2,000.00	4,000.00
Laboratory, chemical apparatus, etc	6,900.00	6,900.00
Laboratory, adulteration of food	15,000.00	5,000.00
Laboratory, investigation of soils	....	3,000.00
Experiments in the manufacture of sugar	20,000.00	10,000.00
Investigating the history and habits of insects	20,300.00	20,300.00
Botanical investigations and experiments	30,000.00	25,000.00
Vegetable pathological investigation and experiments	20,000.00	20,000.00
Fiber investigations	5,000.00	....
Microscopical investigations	2,000.00	2,000.00
Pomological information	5,000.00	5,000.00
Investigations in ornithology and mammalogy	17,500.00	17,500.00
Report on forestry	20,000.00	21,500.00
Inquiries relating to public roads	10,000.00	10,000.00
Irrigation investigations	6,000.00	8,000.00

* This appropriation was left out of the estimates for the ensuing year for the reason that it was not a proper charge against the Department of Agriculture. The payment of the money is made by the U. S. Treasury directly to the Agricultural Experiment Stations, and the Secretary of Agriculture has no control whatever over the sums appropriated.

Comparison of the appropriations for the fiscal year 1894, etc.—Continued.

Object of appropriation.	Appropriated for 1894.	Estimated for 1895.
Agricultural experiment stations	$720,000.00	....
Office of Experiment Stations	25,000.00	$25,000.00
Nutrition	....	10,000.00
Total	2,372,400.00	1,379,620.00
Weather Bureau:		
Salaries	179,530.00	167,090.00
Fuel, lights, and repairs	9,700.00	8,000.00
Contingent expenses	13,700.00	10,000.00
General expenses	748,170.00	669,133.06
Total—Weather Bureau	951,100.00	854,223.06
Grand total for the Department	3,323,500.00	2,233,843.06

The accompanying table presents, by years, the various amounts appropriated for the U. S. Department of Agriculture, together with the sums disbursed on each, from its inception as a section of the Patent Office in 1839 to the year 1893, inclusive, covering a period of fifty five years and involving a sum of over $17,000,000, or an average of $309,759.65, a most economic showing for so important an interest as agriculture represents.

The first decided increase in the appropriation for the Department occurred in 1888, when the appropriation for the Bureau of Animal Industry was greatly augmented. In 1889 the total appropriation was largely increased owing to the provision then made for the "Agricultural Experiment Stations;" and the transfer of the Weather Bureau to the Department in 1891 nearly doubled the total appropriation.

It will be noticed that the amount disbursed for certain years is larger than that appropriated. This seeming inconsistency is explained by the fact that the unexpended balance of the previous year in each case was reappropriated.

Appropriations and disbursements of the U. S. Department of Agriculture, 1839–1893.

Year.	Amount appropriated.	Amount disbursed.	Year.	Amount appropriated.	Amount disbursed.
1839	$1,000.00	$500.00	1868	$279,020.00	$259,018.20
1840	....	500.00	1869	210,197.70	237,779.67
1841	....	....	1870	156,440.00	149,500.00
1842	1,000.00	1,000.00	1871	188,180.00	184,268.00
1843	2,000.00	2,000.00	1872	197,070.00	191,362.91
1844	2,000.00	1,071.73	1873	204,620.92	206,941.77
1845	3,000.00	3,650.00	1874	257,690.00	227,493.11
1846	....	....	1875	337,380.00	319,939.19
1847	3,000.00	478.27	1876	249,120.00	208,021.14
1848	4,500.00	2,200.00	1877	194,686.96	192,134.12
1849	4,500.00	4,282.22	1878	198,640.00	197,634.94
1850	4,500.00	4,500.00	1879	204,900.00	204,860.00
1851	5,500.00	4,500.00	1880	201,000.00	199,861.72
1852	5,000.00	6,217.78	1881	255,460.31	247,608.84
1853	5,000.00	4,196.26	1882	359,011.05	350,410.91
1854	10,000.00	6,192.39	1883	480,468.68	463,013.20
1855	50,032.93	34,744.28	1884	416,638.31	443,615.27
1856	30,000.00	45,000.00	1885	655,190.00	558,194.64
1857	75,000.00	85,000.00	1886	676,953.09	518,175.68
1858	63,500.00	63,500.00	1887	658,442.73	629,088.06
1859	60,000.00	59,657.25	1888	1,019,219.06	1,003,355.12
1860	40,000.00	40,000.00	1889	1,132,996.68	1,104,413.17
1861	60,000.00	50,000.00	1890	1,087,765.19	921,618.11
1862	64,000.00	74,000.00	1891	1,334,502.03	1,232,304.19
1863	80,000.00	79,633.51	1892	2,330,332.88	2,271,312.72
1864	119,770.00	104,840.70	1893	2,540,060.72	2,351,629.68
1865	150,694.05	155,104.05			
1866	167,787.82	167,487.82	Total	17,036,781.11	16,033,210.32
1867	199,100.00	189,400.00			

Inquiry is frequently made as to the availability of a balance remaining to the credit of an appropriation at the end of a year and the possibility of carrying the same to some other appropriation which is practically exhausted, for the purpose of continuing work already undertaken but which is checked for want of further means. All persons making such inquiries are respectfully referred to section 3678 of the Revised Statutes, which provides that all sums appropriated shall be applied solely to the object for which they are respectively made—that is, an appropriation for pomological information can not be used for collecting statistics, purchasing seed, or for any other purpose than that specifically stated in the law.

DIVISIONAL DUTIES.

In concluding this report, it is gratifying to be able to state that all work of the division is up to date, which is the result of a well-established practice of the office to audit accounts in the order of their reception, except in very unusual cases. Attention is also called to the fact that there appears to be an impression in the minds of the uninitiated that the Division of Accounts of the Department of Agriculture is mainly an office for disbursing public funds, notably salaries to employees, whereas it is, as plainly indicated by the title, a "Division of Accounts and Disbursements." In this division, unlike disbursing offices in other Executive Departments, all transactions pertaining to the expenditures of the Department are prepared and fully completed. The large part of the work which is done exclusively in this division is in other Departments partially or wholly performed in the various bureaus or divisions to which it belongs, thus saving to the disbursing offices thereof much labor and serious annoyance; therefore, it is earnestly believed that there is more actual work accomplished in the Division of Accounts proper of the Department of Agriculture than in any other disbursing office of the Government. In this division are kept all records relating to the financial interests of the Department. Requisitions for supplies, contracts, agreements, advertising, letters of authority, etc., are arranged and filed; inquiries relating to business transactions are answered, payments of every description are made, and letters transmitting the same are written; all vouchers are completed and audited; the estimates of appropriations are finally arranged and adjusted; the pay rolls of the Department are made up in and the employees paid from this office; the bookkeeping for the Department accounts is done here; all work relating to the Appointment Division is likewise performed in this office, and much other business of an intricate and difficult nature, requiring clerical ability of a high order. In this connection it should be observed that the employees of the Division of Accounts and Disbursements have acquitted themselves of the difficult work assigned to them with zeal, faithfulness, and efficiency.

Mr. J. B. Bennett, appointment clerk of this Department, has furnished the following statement, which may be appropriately here inserted:

Statement of the number of officers and employees in the Department of Agriculture appointed from each State and Territory and the District of Columbia, and the aggregate amount of their salaries or compensations on July 1, 1893.

State.	Number appointed.	Salaries.	Other employees.		Per capita.
			Number.	Total compensation per day.	
Alabama	38	$10,347.37			$272.30
Arkansas	20	6,248.20			312.41
California	33	32,432.25			982.79
Colorado	9	10,300.08			1,144.45
Connecticut	16	18,177.92			1,136.12
Delaware	4	3,440.00			860.00
Florida	22	15,795.39			717.97
Georgia	47	13,199.25			280.83
Idaho	3	750.00			250.00
Illinois	139	113,646.24	*3	$11.20	835.63
Indiana	43	43,565.50			1,013.15
Iowa	31	26,897.50			867.66
Kansas	84	59,086.38			703.40
Kentucky	19	10,407.24			547.75
Louisiana	32	11,140.48			348.14
Maine	13	9,511.08			731.62
Maryland	55	50,315.58	*2	3.00	947.46
Massachusetts	88	70,167.52			797.36
Michigan	67	62,308.12			929.97
Minnesota	29	25,987.99			896.13
Mississippi	31	11,091.12			357.77
Missouri	79	70,558.55			893.14
Montana	9	6,984.20			776.02
Nebraska	88	80,165.13			910.96
Nevada	3	4,691.08			1,563.69
New Hampshire	7	5,221.96			746.00
New Jersey	35	34,354.00	*1	10.00	1,010.44
New York	136	139,080.32			1,022.64
North Carolina	45	26,383.70			586.30
North Dakota	4	2,805.21			701.30
Ohio	64	42,684.77			666.94
Oregon	15	8,943.25			596.21
Pennsylvania	90	77,386.87			859.85
Rhode Island	8	4,271.08			533.88
South Carolina	35	8,278.71	*1	1.50	243.49
South Dakota	11	9,171.08			833.73
Tennessee	33	18,352.74			556.14
Texas	42	19,600.36			466.67
Vermont	8	5,850.08	*1	5.00	835.72
Virginia	75	58,567.67	*3	6.00	813.44
Washington	15	11,387.92			759.19
West Virginia	20	9,174.25			458.71
Wisconsin	56	38,924.62			695.08
Wyoming	4	3,613.84			903.46
Arizona	3	2,817.12			939.04
New Mexico	7	6,075.08			867.87
Oklahoma	3	2,575.08			858.36
Utah	4	3,775.08			943.77
District of Columbia	134	102,759.12	*15	28.50	863.52
Indian Territory	1	36.50			36.50
Total	1,857	1,409,304.58			

* Number of employees whose compensations are per diem, their services being temporary or intermittent. Their number is included in the number of those appointed.

Highest per capita: Nevada, $1,563.69; lowest per capita: Indian Territory, $36.50.

REPORT OF THE DIRECTOR OF THE OFFICE OF EXPERIMENT STATIONS.

SIR: I have the honor to present herewith the report of the Office of Experiment Stations for the year 1893.

Very respectfully,

A. C. TRUE,
Director.

Hon. J. STERLING MORTON,
Secretary.

OPERATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

CHANGES IN THE OFFICE FORCE.

Mr. A. W. Harris resigned the directorship of the office September 25, to assume the presidency of the Maine State College, and the present director was at once promoted to succeed him. Mr. E. W. Allen, who has been a member of the staff of the office for several years, was promoted to the position of assistant director. Mr. Allen also retains his work relating to chemistry, foods and animal production, and dairying. The remaining force of the office has been reorganized in the direction of greater specialization of work. Provision has been made for an expert for the departments of horticulture and entomology. The Director and all his expert assistants, except the special agents, entered the service of the Government through examination under the rules of the Civil Service Commission.

WORK OF THE YEAR.

During the past year, as heretofore, the Office of Experiment Stations has examined the work of the agricultural experiment stations in this and other countries with special reference to its practical usefulness, and has collated and published data regarding experimental inquiries in agriculture for the information of station workers, farmers, and others interested in the progress of the science and art of agriculture. The wide extent of researches in agriculture in this closing decade of the century is indicated by the fact that there are now some 320 experiment stations in operation in the different countries of the world. The number and importance of the publications issued by these institutions are ever increasing and the interest taken in their work by intelligent farmers and others is steadily growing. As a result, the task of keeping thoroughly informed regarding their work, and of satisfying the demand for information, has become a formidable one. As far as prac-

ticable, the office endeavors to meet the needs of inquirers through its publications, but it is also obliged to carry on a very extensive correspondence, which covers almost every subject involved in agricultural theory and practice. The amount and quality of the work done in the office during the past year will, it is believed, compare favorably with that of previous years, and are the best testimony to the faithfulness and efficiency of the individual members of the office force.

Publications.—Nineteen documents, aggregating 1,942 pages, have been issued by the office during the past year. Chief among these is the fourth volume of the Experiment Station Record, consisting of 12 numbers, with a classified table of contents and a detailed index. This volume of the Record contains abstracts of 296 bulletins and 25 annual reports of the American stations, and 71 publications of this Department, together with 190 abstracts of foreign publications. The topical arrangement of abstracts adopted in this volume has been received with general approval. Résumés of work on important subjects by leading foreign specialists have been a special feature of the fourth volume. The accounts of station work in the Record are necessarily condensed and in many instances largely technical. Great pains have been taken to confine the mailing list for this publication to such persons as would make the best use of it, but it has been found necessary to considerably enlarge this list to meet the demand for the Record among intelligent farmers.

Among the other publications of the office, the following deserve special notice:

The Handbook of Experiment Station Work (Bulletin No. 15) is a popular résumé of the publications of the stations during nearly twenty years. It consists of several hundred short articles arranged in an alphabetical series, with numerous cross-references. It contains much useful information on a great variety of subjects, showing in brief what the stations have accomplished since their establishment in this country, and will aid in making the results of experiments in the different States available to farmers throughout the country. It will also be useful in pointing out the gaps in experiment station work, and will thus indicate to station workers in what lines their investigations may profitably be undertaken. In many instances further experiments are needed to prove the reliability of the results thus far obtained. The demand for the Handbook has been very great, and promises to continue as the bulletin becomes more widely known.

In January, 1893, the National League for Good Roads held a convention in the city of Washington, the proceedings of which have since been published as Bulletin No. 14 of this office. The addresses made at that convention bring out clearly the need of earnest effort for the improvement of our country roads, and also show something of the good which has been accomplished by intelligent methods of road construction. It is hoped that this document will help to increase the interest in this subject throughout the country and will prepare the way for the future work of this Department in the same line.

The work of the experiment stations in this country has thus far related almost exclusively to improvements in the kinds and culture of crops and to their use as food for domestic animals. It seems desirable that questions relating to the use of our agricultural products as food for man should also be considered by these or similar institutions. A suggestive article by Mr. Edward Atkinson, regarding the establishment of food laboratories in connection with the stations, has recently

been issued as Bulletin No. 17 of this office. The office has also undertaken the work of collating information regarding the methods and results of food investigations at home and abroad. It is hoped that this work will serve as a basis for further studies by such stations as have the proper equipment of men and resources for this line of investigation.

In view of the increased attention to the feeding of sheep for mutton in some sections of the country, and the need of more abundant forage for these animals, especially during the autumn, a Farmers' Bulletin (No. 11) on the culture and uses of the rape plant was prepared for general distribution. The author of this bulletin is Prof. Thomas Shaw, of the Ontario Agricultural College, who has devoted much time to experiments with this plant.

Card index of experiment station literature.—The work on the card index of experiment station literature has proceeded steadily, but for various reasons it has not been practicable to print and distribute as many cards during the year as was hoped. The installments of the card index thus far sent out include 3,300 cards, covering most of the literature for the years 1890 and 1891. The office has on hand the manuscript for the cards covering the earlier literature of the stations and these will be printed next in order. Enough of the index has been distributed to the agricultural colleges and experiment stations to demonstrate the usefulness of this work, and these institutions are very desirous that the index should be brought up to date at the earliest practicable time. It is hoped that it will hereafter be practicable to print these cards with such regularity that within a few months the arrears of the work will be cleared away. After this is done the index can easily be kept up to date. Free distribution of this index has been made only to agricultural colleges and experiment stations. Congress has granted permission to sell sets of the index at a price covering the expense of printing them. This has been fixed at $1.25 for a set of the division blocks and cards and $2 per thousand for the index cards. About 175 sets have been printed for sale, a considerable number of which have already been asked for.

World's Fair work.—In common with other branches of the Department, the Office of Experiment Stations has given a large share of its time during the past year to work connected with the World's Columbian Exposition. This work has been carried on in coöperation with committees of the Association of American Agricultural Colleges and Experiment Stations. After the plan of the coöperative college and station exhibit had been matured by the office and the committees, the several colleges and stations prepared their exhibits under the direction of the committees. The preparation of an exhibit of the work of the office and the planning of laboratories illustrating methods of college and station work in chemistry and biology were assigned to this office. The transportation and installation of the exhibit were also done under direction of this office and proved to be a much greater task than was anticipated. Members of the office force acted as directors of the exhibit during three months of the Fair and assisted in the work of demonstration in the laboratories connected with the exhibit. A brief account of the exhibit is included in the report of the Assistant Secretary (page 80).

Relations with foreign experiment stations.—The visits made to foreign experiment stations by Prof. W. O. Atwater as representative of this office have brought the office into cordial relations with many of the most distinguished foreign investigators. Numerous foreign workers

in agricultural science have visited this country during the past year and there have been many opportunities for personal conferences which have brought the office much interesting information and have established relations with foreign institutions which will undoubtedly be of mutual service in the future. The office has also by correspondence and exchange of publications largely increased its acquaintance with the methods and results of work in agricultural science throughout the world. It is hoped that before long the office will be in regular communication with all the institutions which are working in the same lines as our own experiment stations.

Visiting stations and conventions.—Owing to the press of other work, particularly in connection with the World's Fair, members of the office force have been able to visit only a few stations during the past year. Representatives of the office attended the annual convention of the Association of American Agricultural Colleges and Experiment Stations, and the agricultural congresses held at Chicago.

Collection of publications.—Not only have the current publications of the stations been carefully collected and catalogued, but much has been done toward completing the files of earlier publications and obtaining publications issued by foreign stations.

During the past year the office has been the intermediary for a number of exchanges of the rarer publications between different stations, and as far as practicable is desirous of aiding the stations in completing their files of station and other publications.

Mailing list of the office.—During the past year, as heretofore, the office has taken great pains to revise its mailing lists so as to insure the distribution of its publications to those who will make good use of them. The number of requests for these publications from institutions for research and education, journals, and individuals in this and other countries is steadily increasing. At the request of the Division of Statistics, a copy of a single number of the Experiment Station Record was sent to 2,500 of its county crop correspondents. As the result of this distribution, nearly 2,000 of these correspondents asked to be added to the list of regular recipients of this publication. As the publications of the office are very largely works of reference and treat of a wide range of subjects, there is a growing demand for complete sets of these publications.

Reports of the colleges having agricultural courses.—The reports of the colleges receiving appropriations under the act of Congress of August 30, 1890, as deposited in this office during the past year, have indicated that these institutions are in general taking increased interest in the educational needs of farmers. It is gratifying to note the efforts being made to attract the youth more numerously from the farms to the colleges by the establishment of short courses. The attempt to extend the influence of the colleges into the homes of the farmers through courses of home readings is also to be commended. Statistics relating to these institutions and some general statements regarding their work are given in another part of this report (page 448).

New work.—In addition to work along the lines above referred to, plans are being made for disseminating a larger amount of practical information in popular form. The effort will be made to give the farmers throughout the country prompt news regarding the results of investigations at the several stations, as far as this is practicable with the coöperation of agencies already in existence for the diffusion of information. In many cases the work done at a single station is of interest and importance to the people in many regions, and it is only just that

they should receive word concerning it from an authoritative source. The stations are so largely supported from the national treasury that whatever they accomplish belongs to all our people.

As the work of the stations progresses, the need of more complete facilities for ascertaining what has been done in any particular line of investigation is increasingly felt. In order that the time and energy of the investigator may be wisely conserved, he should be provided with ready means for obtaining the information he requires in order to plan and properly conduct his investigations. As this office necessarily traverses a wide range of literature on agricultural science, it has unusual opportunity for bibliographical work in these lines. Arrangements have been made with a view to accumulating and indexing such bibliographical information as is likely to be of service to station workers. Digests on special topics are also contemplated.

PRACTICAL EXPERIMENTS AT THE AGRICULTURAL EXPERIMENT STATIONS.

With a view to showing some of the ways in which the stations are doing work of immediate practical benefit to farmers, the following brief accounts of recent experiments in several different lines have been prepared for this report.

THE MANUFACTURE OF CHEESE.

Cheese-making has been the subject of one of the most extensive and thorough investigations of a single farm operation ever undertaken by the experiment stations. Various stations had from time to time reported observations covering a few trials, but there was until late years a lack of continued systematic study of the subject in all its details and under all conditions. About three years ago the New York State Station in coöperation with the State dairy commissioner commenced a series of investigations in cheese-making which have been continued through three seasons and are not yet completed. The object has been to determine the losses in the process of manufacturing milk of varying richness into cheese, the exact sources of these losses, and the means of reducing them to a minimum. The experiments have been of a most thorough and systematic nature, and have been carried on in each month of the working season, both at the station at Geneva and at a number of different cheese factories within the State. Milk of varying richness, from skim milk to milk made abnormally rich by the addition of cream, has been used in these experiments, and the details of manufacture have been varied to include a very wide range of treatment of the milk, the rennet, the curd, and the green cheese.

In all some 150 separate experiments have already been made. The details of the cheese-making have been carried out by expert cheese-makers and in every case the milk, the waste products, and the cheese have been analyzed at the station. The studies embrace among other things the following subjects: Losses of milk constituents in cheese-making; effect of composition of milk on the yield and composition of cheese and on the loss of milk constituents in making; comparisons of the Cheddar and stirred-curd processes, of commercial and homemade rennet extract, and of using different amounts of rennet; and the changes taking place in the ripening of cheese. The investigations

are still in progress. Some of the indications which they have thus far furnished are as follows:

The proportion of the fat in the milk lost during the process of manufacture varied considerably, but averaged between 7½ and 8 per cent, or roughly about one-third of a pound of fat for each 100 pounds of milk used. The loss is fully as small as, if not smaller than, the losses in butter-making with improved appliances, and considerably less than the average losses where ice is not used in raising the cream. In normal milk the loss appeared to be independent of the percentage of fat in milk, i. e., was very nearly the same from normally rich milk and from poor milk. The variations in loss of fat were due either to the condition of the milk or to some special conditions employed in the manufacture. In the case of skimmed milk the proportion of fat lost was greater, and in the case of milk to which cream had been added the loss was less than from normal milk.

The loss of casein and albumen, or the cheesy constituents of the milk, did not appear to be affected by the percentage of these constituents in the milk. It was practically the same whether skim milk, normal milk, or milk to which cream had been added was used. It amounted to about 24 per cent of the entire amount contained in the milk, or about 12½ ounces per 100 pounds of milk.

As to the effect of the composition of the milk on the yield of cheese, the investigations thus far have shown the fat to be by far the most prominent factor in determining the yield. In nearly all the experiments made the yield of cheese has been proportional to the percentage of fat in the milk, being higher with milk rich in fat. This held true in the case of cheese made from skim milk and from milk to which cream had been added. Nor was this entirely due to the additional amount of fat which the richer milk added to the cheese, for it was found as a rule that more water was retained in the cheese when the milk was richer in fat. In fact, the fat appeared in most cases to have considerable influence on all the milk constituents recovered in the cheese. As an average of the work of two seasons, it was found that for every increased pound of fat in the cheese there was also from one-third to 1 pound more water and about 9½ ounces more casein and albumen.

This brings out in a striking manner the desirability of using milk rich in fat for cheese-making, and indicates that rich milk is not less desirable in cheese-making than in butter-making. In fact, it has led to the statement that "the so-called cheese cow—i. e., the cow which is good especially for cheese rather than for butter—does not exist, and that wherever a cow is found that is good for cheese-making purposes, the milk of that cow is equally good for the manufacture of butter." * The result of the Columbian dairy test points in the same direction.

An increase of casein and albumen in the milk was generally, although not always, accompanied by a slight increase in the yield of cheese and in the amount of casein and albumen recovered in the cheese per 100 pounds of milk.

In general the fat in the milk exercised a greater influence upon the composition of the cheese than any other constituent of the milk. The percentage of fat in the cheese increased, as a rule, when the percentage of fat in the milk increased, and *vice versa*, but this increase was irregular and was not proportional to the increased fat content of the milk. The water was the most variable constituent of green cheese. There

* W. W. Cooke, Vermont Station Annual Report for 1892, p. 123.

did not appear to be any definite relation between the percentage of casein and albumen in normal milk and the percentage in the cheese.

To summarize, the amount of fat in the milk used for cheese-making had very little effect on the loss of fat, except in the case of skim milk or milk to which cream had been added; but it affected the per cent of fat in the cheese as well as the proportion of other ingredients recovered in the cheese, and very materially affected the yield of cheese both from normal milk, skim milk, and milk to which cream had been added.

The amount of casein and albumen in the milk, on the other hand, had no effect on the loss of these ingredients, no definite effect on the composition of the cheese, and only a slight effect on the yield of cheese. These results have been corroborated by experiments at the Minnesota and Vermont Stations.

On an average of all the experiments thus far reported by the New York Station, 100 pounds of average whole milk yielded 10·78 pounds of green cheese, and for each pound of fat contained in the milk there was made 2·65 pounds of green cheese. That is, a milk containing 4 per cent of fat yielded 10·76 pounds of green cheese per 100 pounds, on an average. The average milk of all the experiments contained 4·07 per cent of fat, and hence the milk averaged 10·78 pounds of green cheese per 100 pounds, as stated above. The yield as calculated from the percentage of fat was much more nearly constant than that calculated from the quantity of milk. The average yield of cheese per 100 pounds of milk in each of the separate series of experiments was 12·35, 9·90, 10·12, and 10·76 pounds, respectively; while the yield of cheese per pound of fat in the milk was 2·71, 2·63, 2·54, and 2·74 pounds, respectively. Hence, there can be little doubt that the percentage of fat in milk is a good indication of its value for cheese-making, and may serve as the basis for paying for milk at cheese factories.

As between the Cheddar and stirred-curd processes, the losses in manufacture and the quality of the cheese were essentially the same by both, but the Cheddar process retained a little more water in the cheese as a rule, and consequently made a little more cheese from a given quantity of milk.

Cutting the curd in hard or in soft condition gave practically the same results as to the loss of milk constituents, the yield of cheese, and its quality.

EXPERIMENTS IN RAISING AND BREEDING SHEEP.

The question of the economical raising of sheep has received attention at the Iowa, Massachusetts State, Michigan, Minnesota, New York Cornell, South Dakota, Texas, Utah, and Wisconsin Stations, especially at the last-named station. At this station quite large flocks of sheep are kept, with a trained shepherd to care for them and an expert to plan and superintend the experiments in feeding, treatment, and breeding.

Feeding grain to unweaned lambs and to ewes.—The Wisconsin Station has made two series of experiments to compare the effects of feeding grain to unweaned lambs, or to their mothers, with feeding no grain to either. The object was to ascertain whether grain could be profitably fed when lambs and ewes were running together on a good pasture, and if so, whether it was better to feed it to the lambs or to the ewes. The grain was a mixture of linseed meal, corn meal, and wheat bran. The conclusion was that "it paid to feed the lambs all the grain they would eat. The lambs that have previously received grain will not

lose in weight because of the weaning. As a result of the grain feeding they have gradually become able to feed themselves, and when the weaning period arrives they do not fret or require the assistance of their dams to keep gaining weight." There was little or no result from feeding the grain to the ewes, and the conclusion is reached that "when the ewes have been properly fed during the winter so as to be in good condition at lambing time, it does not pay to feed them grain when on good pasture with the object of securing more rapid and profitable gains in the lambs." In another trial the profit was $1.49 more from three lambs receiving grain than from others without grain.

Cost of fattening lambs.—Lambs ten days old were fed at the Wisconsin Station on cow's milk from a bottle. The feeding lasted three weeks. The cost per 100 pounds of gain during this time, with milk at 60 cents per 100 pounds, was $3.47. They were then changed to sweet skim milk, oats, green clover, and green fodder corn, and fed for four weeks. Valuing skim milk at 25 cents per 100 pounds, oats at 26 cents per bushel, etc., the food per 100 pounds of gain cost $2.30. From that time on the cost gradually increased with the weight of the lambs and the amount of grain they required, until, when five months old, the cost was $4.50 per 100 pounds of gain. Compared with pigs the lambs did exceedingly well, both in cost of food and in gain.

The same station reports a comparison of feeding grain to lambs, (1) for about two months before weaning, (2) for about four and one-half months between weaning and fattening, and (3) during fattening only, for about three months. The grain was a mixture of corn meal and linseed meal with oats and bran. In the first period (unweaned), the three lambs in the grain-fed lot gave a profit of $1.49 more than the three without grain. In the second period (after weaning), five grain-fed lambs gave a profit of $2.14 more than those that had not received grain. In the third period (during fattening), the lot which had previously received no grain gained 8 pounds more than the others, and the cost of the gain was only 3 cents less. "The previous feeding of the lambs had no effect on their progress in fattening during the third period. * * * It paid to feed the lambs grain through all the periods."

The New York Cornell Station compared the cost of fattening lambs on the following rations: (1) Timothy hay, whole corn, and roots; (2) wheat bran, cotton-seed meal, clover hay, and roots; (3) whole corn, wheat bran, cotton-seed meal, timothy hay, and roots; and (4) whole corn, wheat bran, cotton-seed meal, and timothy hay. Ration No. 2 was much the richest in protein (nitrogenous materials) and No. 1 the poorest. The cost per 100 pounds of gain in live weight was: Ration No. 1, $7.59; No. 2, $6.03; No. 3, $6.36; and No. 4, $7.82.

At the Iowa Station the following rations were compared: No. 1, oats, linseed meal, bran, and hay; No. 2, shelled corn, hay, and oat straw; and No. 3, oats, shelled corn, bran, linseed meal, and hay. The lambs weighed from 65 to 100 pounds each at the beginning of the trial, and were fed on the above rations continuously from December 1 to the following April. No. 1 was the richest in protein and No. 2 much the poorest. With linseed meal at $25, bran at $16, hay at $5, and straw at $2 per ton, and oats at 25½ cents and corn at 30 cents per bushel, the cost per 100 pounds of gain in live weight was as follows: No. 1, $6.20; No. 2, $5.70; and No. 3, $5.65. "The corn-fed lambs (No. 2) made no apparent gain. The gain in weight seemed to be the result of fattening instead of growing."

The Michigan Station reports a comparison of corn silage with roots, each at $2.50 per ton, when fed with wheat bran and oats at current prices. The cost per 100 pounds of gain was $4.96 on silage and $4.38 on roots.

Linseed meal and cotton-seed meal were compared on young lambs at pasture at the Wisconsin Station. From July 16 to September 24 one lot was fed all it would eat of a mixture of equal parts of linseed meal and corn meal, and another lot a mixture of equal parts of cotton-seed meal and corn meal. Valuing corn meal at $14, linseed meal at $20, and cotton-seed meal at $25 per ton, the cost of food, exclusive of pasturage, per pound of gain in weight was 2 cents for the lot on linseed meal and 3⅓ cents for the lot on cotton-seed meal. The average gain per week was 3·3 pounds for the former (linseed meal), and 2·95 pounds for the latter.

In four out of five experiments reported a nitrogenous ration, i. e., one relatively rich in highly nitrogenous feeds as linseed meal, clover hay, etc., gave a more rapid gain in live weight than a carbonaceous ration, or one made up principally of foods poor in nitrogen, as hay, straw, corn meal, etc.

Shearing wethers before fattening them.—The question of the expediency of shearing wethers previous to the commencement of the fattening period has been studied at the Wisconsin Station for two seasons. The first season wethers were shorn in December and again in April; and in the second season early in November and again in March. The results were unfavorable to the practice the first season, but the second season's result "affords evidence of some advantages connected with shearing twice that can not be overlooked." In the latter trial the sheep shorn twice yielded the most wool, but the fiber was shorter; they also gained slightly more in weight, though the difference was small.

Breeding.—The Wisconsin Station has undertaken to produce an all around mutton and wool sheep by crossing a Shropshire ram on an American Merino ewe. The results thus far are very encouraging, as will be evident from the following extracts from reports on the subject:

In quality the wool of the first cross is slightly inferior to the Merino and much superior to that of the Shropshire. It is finer, softer, and purer than that of the Shropshire, while it is only inferior to the wool of the Merino in fineness.

In condition the first cross wool is bright, and owing to the density of the fleece it keeps clean. The wool might be improved somewhat in respect to its strength, for it appears to have lost some of the elasticity and strength of fiber that is noticeable in the Merino wool. * * *

The body of the sheep shows marked improvement towards a mutton type from that of the Merino. * * *

The wool of the second-cross ewes is larger than that of the Merino or the first cross, but it is not equal to either in density or evenness. It is inferior in fineness, softness, and purity, but in these respects it is superior to typical Shropshire wool. It is a bright, strong, and long wool, that would bring a high price in present markets. In critically examining the appearance of the second cross it is evident that the Shropshire type is closely approached. In form the sheep of this cross are long and possessed of the rotundity of form that is a Shropshire characteristic. * * * A marked improvement has been made over the first cross, particularly in the plumpness of the thigh and fullness between the hind legs. There appears to be no evidence of a decrease in constitution. * * *

As the third crosses are the lambs of this year it would be attempting too great a forecast to place an estimate on them based on their present appearance. They do not, however, show many of the loose folds of skin that have been observable in the lambs of the first cross at their ages. It seems that they will be very similar to the second cross in type and fleece. We have, however, sufficient data from the previous crosses to believe that they point the way to those who wish to supplant their Merino flocks with sheep of mutton qualities.

HOME-MIXING OF FERTILIZERS.

The feasibility and desirability of home-mixing of fertilizers have been clearly demonstrated by the stations. The published results of investigations by stations engaged in the examination of fertilizers leave no doubt regarding the fact that "from such raw materials as are in our markets, without the aid of milling machinery, mixtures can be and are annually made on the farm which are uniform in quality, fine, and dry, and equal in all respects to the best ready-made fertilizers."

The nature of the investigations by which these conclusions have been reached is illustrated by recent work in this line at the New Jersey Station. A comparison at the station (reported in its Bulletin No. 93) of ten samples of home-mixed fertilizers with twelve leading manufactured brands showed that in two samples of the former the fineness closely approached perfection, 90 per cent, and in one case fell below 70 per cent; in the manufactured brands the greatest fineness was 86 per cent, and in two cases it fell below 70 per cent. It appears from these figures that farmers using the ordinary appliances of the farm and working on the high-grade materials readily obtainable in the market make even better mixtures than the manufacturers.

The average composition of all manufactured fertilizers examined by this station during 1892 and of the home mixtures examined during 1893 was as follows:

Fertilizer.	Nitrogen.	Available phosphoric acid.	Potash.
	Per cent.	*Per cent.*	*Per cent.*
Manufacturers' mixtures	2·74	7·70	4·50
Home mixtures	4·02	8·44	9·36

If manufacturers' mixtures had contained as much actual food as the home mixtures the total amount sold last year would have been contained in 23,172 tons, instead of 33,821 tons, or a difference of 10,649 tons; that is, the 10,649 tons of material mixed, bagged, freighted, and sold as part of the various brands contained no plant food whatever, and was, therefore, entirely useless.

[Now, it has been shown that the average charge of manufacturers for mixing, bagging, shipping, etc., is $8.53 per ton.] Since it costs no more to mix, bag, freight, and sell a high-grade mixture than a low grade, the cost to the farmers for handling this worthless material amounted in 1892 to $90,835. It has been shown by the work of this station that the average composition of mixed fertilizers and the fixed charges of the manufacturers have not materially changed in the last ten years. The total sales reported during this time were 247,000 tons, containing, on the same basis of comparison, 77,000 tons of worthless material, which cost farmers over $656,000, and from which they could expect no returns whatever. The manufacturers are not altogether to blame for this state of affairs; they aim to supply the demands of their trade, which are too often for cheap goods.

The home mixtures examined represented a purchase of 700 tons. The average station valuation of the different samples exceeded the cost by $4.11. Comparing the average cost per pound of the nitrogen, phosphoric acid, and potash in these mixtures and in the manufactured brands sold in 1892, we have:

Fertilizer.	Nitrogen.	Available phosphoric acid.	Potash.
	Cents.	*Cents.*	*Cents.*
Manufacturers' mixtures	24.8	9.4	6.7
Home mixtures	14.9	5.7	4.0

If the constituents in the average home mixture this year had been bought at these [the manufacturers'] figures the cost per ton would have been $49.27 [while the actual cost was $29.70]. * * * The difference of $19.57 per ton, applied to the 700 tons represented, makes a total of $13,699. This is certainly a good return for cash payments instead of credit, for selecting materials suited to the needs of the soil and plant instead of buying hit or miss, and for using the regular labor of the farm in mixing instead of paying others who do the work no better.

The actual cost of mixing, in the experience of Rhode Island farmers who have tried it, varies from $1 to $1.50 per ton (Rhode Island Station Bulletin No. 23).

The most obvious advantages of the practice of home mixing of fertilizers which an investigation of the subject appears to demonstrate are:

(1) *Reduction in expense.*—This is clearly brought out in the figures given above.

(2) *A definite knowledge of the nature of the plant food employed.*—Each ingredient can be separately examined by the purchaser, inferior materials can be readily detected, and those best adapted to special needs selected. "It is self evident that an intelligent farmer by home-mixing is better able than anyone else can be to adapt the composition of his fertilizers to the special requirements of his land as well as of his crop."

(3) *The indirect educational advantages.*—This is probably the strongest recommendation of the practice. It encourages a spirit of inquiry among those using fertilizers, and leads them to study and apply the results of agricultural research, thus contributing much toward the fixing of the practice of farming on a rational, scientific basis.

With the vast amount of station literature sent broadcast through the country, giving the latest and most reliable information on the best sources of supply of fertilizing materials, the most effective mixtures and combinations for different crops and soils, and the best methods of application, there is no reason why intelligent home-mixing of fertilizers should not be generally practiced to the marked advantage of the farming community.

BARNYARD MANURE.

This important farm resource has been the subject of study by several experiment stations in past years, but to the New York Cornell Station (Bulletins Nos. 13, 27, and 56) belongs the credit of carrying on the most thorough and comprehensive work in this line. The investigations of this station, continued during the past year, have been especially valuable in calling attention in a striking manner to a somewhat neglected phase of American farm management. They have clearly brought out the high value of the manure annually produced by the various classes of farm live stock, the influence of food, age of animal, amount of bedding, and other factors on its quality, and have led to suggestions of means of improving the present wasteful methods of managing manure.

The following table gives the kind of food used and the amount and quality of the manure produced during the winters of 1891–'92 and 1892–'93 by the classes of farm animals named, fed liberally and supplied with sufficient bedding to keep them clean:

Amount, composition, and value of manure produced by different kinds of farm animals.

Animals.	Food.	Analyses and value per ton of manure.					Amount and value per 1,000 pounds live weight per day.		
		Water.	Nitrogen.	Phosphoric acid.	Potash.	Value per ton.*	Pounds per day.	Value per day.*	Value per year.*
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*				
Sheep....	Hay, corn, and oats; or hay, wheat bran, cotton-seed meal, and linseed meal.	59·52	0·768	0·391	0·591	$3.30	34·1	$0.072	$26.09
Calves...	Skim milk, corn meal, wheat bran, and hay; or corn meal, linseed meal, wheat bran, and hay.	77·73	0·497	·172	·532	2.18	67·8	.067	24.45
Pigs.....	Skim milk, corn meal, and meat scraps; or corn meal, wheat bran, and linseed meal.	74·13	0·840	·390	·320	3.29	83·6	.167	60.88
Cows....	Hay, silage, beets, wheat bran, corn meal, and cotton-seed meal.	75·25	0·426	·290	·440	2.02	74·1	.080	29.27
Horses...	Hay and a mixture of oats, corn meal, and wheat bran.	48·69	0·490	·260	·480	2.21	48·8	.076	27.74

* Valuing nitrogen at 15 cents, phosphoric acid at 6 cents, and potash at 4½ cents.

It will be observed that the largest amounts of manure (mixed excrement and litter) recovered per day were obtained where the food was highly nitrogenous, as in case of pigs, or largely liquid, as in case of calves. In either case the increase was due to an increased secretion of urine necessitating the use of a larger supply of bedding.

The table shows further that the actual amount of nitrogen recovered in the manure is in every case considerably larger than that of potash and about twice that of phosphoric acid, and confirms the statement that barnyard manure is a valuable source of nitrogen—the most fugitive and therefore the most costly element of plant food.

As the values given [in the above table] have been based on those given for the value of commercial fertilizers it does not follow that any farmer under all conditions will be able to get that value from the manure any more than he is guarantied to receive that value from the same amount of plant food in commercial fertilizers. It may be the prices given are too high and that they should be greatly reduced or even cut in two. The value per pound of each fertilizing ingredient should be determined by each farmer for himself as he determines whether he can or can not afford to buy commercial fertilizers at the market price. These values, however, afford a means of comparing the value of manures made by the different kinds of domestic animals and vary from $24.43 per year from calves to $68.88 per year from pigs. These values are calculated for the year at the same rate and value for the whole year as the average of the experiments, which would probably be somewhat too high for the classes of animals that are turned to pasture a considerable portion of the year; for animals that are kept in stalls or pens throughout the year there is no reason why the average of these experiments will not represent the production and value for the whole year. It is, therefore, evident that barn manures, when produced from fairly nitrogenous food liberally fed, contain a much larger proportion of nitrogen than either phosphoric acid or potash, and that where commercial fertilizers are used with such manures the most economical application will be secured by applying a much larger proportion of phosphoric acid and potash in the commercial manures than is usually sold in complete fertilizers throughout the State.

There is more variation in the fertilizing value of different feeding stuffs than there is in the value of the excrement from different kinds of domestic animals usually kept on the farm. These experiments, as

well as others carried out by the Maine Station, clearly demonstrate the fact "that the quantities of nitrogen, phosphoric acid, and potash of the manure stand in direct relation to the quantities of the same ingredients in the food." In the experiments at Cornell the average percentages of the different fertilizing ingredients in the food which were recovered in the excrement were as follows: Nitrogen, 70; phosphoric acid, 62; potash 83; average of all three constituents, 71.

Without doubt the general average of the plant food recovered is considerably lower than would be the case in ordinary practice where a larger proportion of mature animals are kept. It is frequently stated in general terms that 80 per cent of the fertilizer value of animal food is recovered in the excrement, and when we consider that of the eleven experiments five were made with young animals, it is fair to presume from the results of these experiments that considerably more than 70 per cent would be recovered in ordinary practice, particularly if a considerable portion of the stock fed were fattening animals.

It is reasonable to infer that the crop-producing power of the manure produced by a given kind of animal will be largely determined by the kind of food consumed.

The following table, adapted from Pennsylvania Report for 1890 (page 27), shows the variation in the manurial value of some of the more common farm products.

Manurial value of farm products

Farm product.	Value per ton.				Manurial value of $10 worth.
	Nitrogen.	Phosphoric acid.	Potash.	Total.	
Meadow hay	$3.47	$0.57	$1.06	$5.10	$5.10
Clover hay	6.83	.78	1.46	9.07	9.07
Potatoes	1.19	.22	.46	1.87	.12
Wheat bran	8.35	2.00	2.10	12.45	7.78
Linseed meal	17.87	2.25	.99	21.11	7.54
Cotton-seed meal	23.06	2.04	2.25	28.35	10.12
Wheat	6.38	.74	.63	7.75	2.58
Oats	6.21	.87	.35	7.43	3.86
Corn	5.62	.83	.30	6.75	3.78
Barley	6.74	.63	.62	7.99	2.96
Milk	1.73	.24	.12	2.09	.88
Cheese	15.40	1.61	.20	17.21	.69
Live cattle	9.04	2.60	.14	11.78	1.18

An examination of this table will reveal in the first place the necessity of distinguishing between feeding value and fertilizing value. It will be seen, for instance, that corn, which is so highly esteemed as a feeding stuff, has a very low fertilizing value. Clover hay has a fertilizing value almost as high as its selling price. It is fair to assume that a ton of the hay will produce a greater value in manure than a ton of corn meal. Other examples might also be taken from the table which would show that the fertilizer value by no means runs parallel with the feeding value. In order to form a correct estimate of the probable value of the excrement produced, the actual amounts of nitrogen, phosphoric acid, and potash in each feeding stuff used must be known, as well as the kind and age of the animal employed.

The table illustrates, moreover, the intimate relation which exists between the feeding of live stock and the maintenance of the fertility of the soil. We see from it—

That the farmer who sells a ton of hay, for example, sells in this ton of hay fertilizing ingredients which, if purchased in the form of commercial fertilizers, would cost him about $5.10; that if he sells 2,000 pounds of wheat he sells an amount of nitrogen, phosphoric acid, and potash which it would cost him $7.75 to replace in

his soil in the form of commercial fertilizers. [Or, looking at it from a somewhat different standpoint], a farmer who sells, for example, $10 worth of wheat, sells with it about $2.58 worth of the fertility of his soil. In other words, when he receives his $10 this amount does not represent the net receipts of the transaction, for he has parted with $2.58 worth of his capital—that is, of the stored-up fertility of his soil—and if he does not take this into account he makes the same mistake a merchant would should he estimate his profits by the amount of cash which he received and neglect to take account of stock.

If now the farmer, instead of selling off his crops, feeds them to live stock on the farm as far as possible, a large proportion of this fertility, as has been shown above, is retained on the farm; and "if the business of stock-feeding is carried to the point where feed is purchased in addition to that grown on the farm, a considerable addition may in this way be made to the fertility of the farm at an almost nominal cost, since it is assumed that feed will not be bought unless its feeding value will at least pay its cost."

It is necessary, however, that the manure thus obtained should be carefully saved and wisely used, for evidence is not lacking to show that without this precaution the margin of profit in stock-raising is likely to be seriously reduced or entirely eliminated.

Experiments at the Maine Station (Report for 1885-'86, p. 42) with sheep have shown that "the urine contained nearly half the potash of the total excrement and from half to three-fourths the nitrogen, but no phosphoric acid, the latter being wholly in the solid excrement." Considering this statement in connection with the fact that urine is subject to rapid decomposition and loss of ammonia, we can readily perceive how necessary it is to carefully conserve the liquid excrement.

It is a well-known fact that the decomposition of manure begins as soon as the excrement is voided, and is so rapid as to result in a short time in a serious deterioration of the product. This is a result of destructive fermentation, and the loss sustained is confined to the nitrogen which escapes either in the free state or as ammonia.

A second and probably more serious cause of loss is the leaching out of the soluble constituents of the manure when exposed to weathering. The investigations of the New York Cornell (Bulletins Nos. 13 and 27) and State (Bulletin No. 23) Stations and the Kansas Station (Report 1888, p. 10), show that manure loosely piled and left exposed will lose fully one-half of its fertilizing value in six months. The value of such leached manure has been carefully tested by the Ohio Station (Bulletin, vol. IV, No. 3) on grain and grass, with the result of showing that the margin of profit from the use of open-yard manure is extremely small.

From these facts it will be seen how important it is to take every precaution to prevent excessive fermentation and to protect the manure from leaching. These results are secured in the first stages, while the manure is under the feet of the animals, by the use of proper absorbents—straw, peat, or earth—and of certain preservatives, such as gypsum, superphosphate, or kainit. When the manure is removed from the stables it should be stored under cover or in water-tight pits in compact heaps to prevent free access of air, and kept moist. By these means destructive fermentation and leaching are prevented, and those fermentations which increase the availability of the fertilizing constituents are promoted. Since barnyard manure, as already pointed out, is much richer in nitrogen than in the other elements of plant food, potash and phosphoric acid, it would be an economical practice to compost it in the heap with materials, such as superphosphate and kainit, which would conserve the manure and at the same time supplement its supply of potash and phosphoric acid.

A review of the field experiments with barnyard manure by the different stations on all kinds of crops and under widely varying conditions of soil and climate shows that the high esteem in which it has long been held is fully warranted. Indeed it is what may be considered a perfect manure, possessing both the physical and chemical properties which ameliorate and enrich the soil, and is well adapted to almost all conditions of soil, climate, and crop.

THE RELATION OF SOIL MOISTURE TO CROP PRODUCTION.

Considerable work has been done by the stations in past years on the physical properties of soils. This has related principally to a study of the temperature of soils under varying conditions of elevation, drainage, etc.; the mechanical constitution of soils (physical analysis), and the amount and movement of soil water as affected by the size and arrangement of the soil particles and by different methods of culture and manuring. Very thorough and systematic work has been done in these different lines by the California, Maryland, South Carolina, and Wisconsin Stations.

The importance of the problems relating to the supply of water in the soil will be readily appreciated when we reflect that "next to temperature the water supply is the most influential factor in the production of a crop." It is well understood that no matter how fertile the soil or how favorable the temperature, if the necessary supply of water be lacking, the crop will fail. Water is a prominent constituent of all plants, but the supplying of the needs of plants in this respect is only one of the functions of soil water. In dissolving and transporting plant food in the soil it exerts an equally potent influence on crop production. We see then how necessary it is for the intelligent tiller of the soil to be familiar with the factors which determine the amount and movement of soil water. The work of the Maryland and Wisconsin Stations in this line has given interesting and suggestive results. Let us briefly review the investigations of these stations, particularly in their more practical bearings.

To illustrate the importance of the subject, Whitney (Maryland Bulletin No. 21), after showing that the average monthly rainfall of 4 inches in Maryland is sufficient for a good wheat crop on the retentive limestone soils, but that the light sandy truck soils retain only 1 inch of this rainfall, which is insufficient for this crop, says:

> If there should be as much difference as this in the amount of water supplied to plants in a greenhouse, those plants which received the most water would develop into large leafy plants, which would be late in coming to maturity, while the plants receiving the less amount of water would be smaller, but there would be a greater tendency to fruit, and the plants would mature much earlier. This is precisely the effect on the two soils under consideration. When wheat is sown on the sandy truck soil it does not tiller well, but throws up one or two stalks which attain hardly any size before each takes on a seed head and the plant ripens. The conditions have not been favorable for the development of a sufficient amount of foliage to gather enough plant food from the soil and atmosphere for a large crop, but the plant has been forced to maturity before it has attained sufficient size. The crop is large in proportion to the amount of food material which has been gathered by the plant, but there is relatively so little of this that it gives a very small yield per acre. On the heavy limestone soil, on the other hand, the crop grows slowly, gets a good root development, tillers well, and produces a mass of foliage which gathers a quantity of food material from the soil and air before it is time to ripen the grain.
>
> In heavy wet soils and in wet seasons plants are inclined to grow very large, and they do not put on as much fruit as they should, considering the size of the plant and the amount of food material that has been gathered from the soil and air. Under these conditions cotton plants, which are extremely sensitive to the wetness of the

soil and to the season, take on a large and rank growth and produce a small yield. On drier soils and in drier seasons the plants are smaller and yield larger crops. Wheat also shows this, although to a less extent than cotton. Under these same conditions tobacco plants are large and rank; the leaves are coarse and sappy and do not cure well or take on good color. In drier seasons and on drier soils the leaves have a finer texture and a brighter color. On the light sandy soils the conditions, as a rule, are unfavorable to wheat and grass, but these drier conditions are distinctly favorable for forcing crops to an early development, and this is what gives them their great value for early truck. By forcing these vegetables to an earlier maturity the vegetables are put on the market two or three weeks earlier than they can be produced on the heavier soils of the State, and they bring a higher price; the same crop grown on a heavier and more moist limestone soil would be so late in coming to maturity that it would have to compete with all other parts of the State, and there would likely be a glut in the market and the crop would bring a very low price. We thus see that the character of the season and the soil has much to do (1) with the total yield of the crop, as with the cotton and wheat crop; (2) with the quality of the crop, as with tobacco; (3) with the time of ripening, as with the truck and vegetables.

He argues that the difference in chemical composition of the soils of Maryland will not account for their difference in agricultural value, but that this is chiefly determined by the size and arrangement of the soil particles and the amount of organic matter present. On this basis he classifies the soil formation of Maryland, obtaining thus from 10 to 15 type soils, each of which is specially adapted to some particular crop. The development and yield of crops on these soils are dependent upon the conditions of moisture and heat, "for if the physical conditions of moisture and heat are favorable, plants can, in general, get all the food they need from nearly all soils," and these conditions vary with the texture of the soil types. The deterioration of lands is largely due to a change in texture.

We have in our common manures and fertilizers very powerful and potent means of maintaining or of changing the texture of the soils and thereby changing the conditions of moisture and heat which they can maintain for the crop, and it is through this physical effect of manures and fertilizers, in controlling the supply of moisture and heat within the soil, under existing climatic conditions, that the chief value of fertilizers and manure lies, rather than in the relatively small amount of plant food which they add to the soil.

Fertilizers alter the texture of soils by changing the surface tension of the water surrounding the minute particles, thus either driving the particles asunder and making the soil more impervious, as is the case where alkalies, urine, etc., are used, or flocculating or rolling them into balls, and thus opening the pores of the soil to the circulation of water, as occurs, for instance, where lime is applied.

This alteration in surface tension of soil water by matter in solution also exerts an influence on its movement, for the investigations of the New York State Station (Reports 1887, 1888) as well as of the Maryland Station have shown that certain fertilizers, such as salt and kainit, increase the surface tension of soil water, thus augmenting the power of soils to draw up water from below in dry seasons, and that others, such as ammonia and urine, reduce the surface tension and thus lessen this power of soils. The practical utility of these facts is so clear as to need no comment.

King, of the Wisconsin Station (Reports for 1890, 1891, and 1892), has studied the question of soil moisture as related to crop production during a number of years. His investigations have given results of the highest practical significance. He finds that, although the lateral movement of soil water is comparatively slow, water may be drawn up in the soil by capillarity from a depth of at least 5 feet, and that this rise may be materially altered by the use of manure and by tillage.

Repeated experiments have shown that the use of barnyard manure increases the available supply of water in the soil, even down to a depth of 4 feet, and that this influence is still perceptible a year after manuring. "Rolling land by firming the soil increases its power of drawing water to the surface from below, and this influence has been observed to a depth of 3 or 4 feet." It also increases the evaporation of soil moisture, and the drying effect of rolling has been found to extend to a depth of 4 feet.

It appears, moreover, that wetting the surface soil increases this translocation of soil moisture, particularly at seasons when evaporation is rapid. For this reason the author recommends that—

Unless the ground is already too wet, the stirring of the surface soil, wherever practicable, should follow just as soon after a considerable rainfall as the tools will work well. The cultivation should, as a rule, be shallow, leaving a thin stratum of the surface soil finely pulverized and completely cut off from the ground below. If this is not done the extremely rapid evaporation which takes place from undisturbed wet soil on hot clear days may, even in a few hours, not only dissipate that which has just fallen, but also a part of that which the rain has caused to be drawn toward the surface from lower levels, and thus leave the ground actually drier, as a whole, than before the rain, even though it may look more moist at the surface.

The practical bearing of these facts is illustrated in connection with the watering of transplanted trees, and with the use of tillage implements.

When dry weather follows the planting of trees it will be evident that simply wetting the surface may, in certain localities, do more harm than good, because in these cases the roots, lying as they do at considerable depths, can not use water which remains at the surface, and as surface wetting may diminish the water content of the deeper soil, the soil about the roots is liable to be rendered drier than before the wetting. * * *

If, however, the surface soil about the trees is deeply spaded before watering, the water will then enter the ground more deeply by the direct course of gravitation, largely unimpeded by capillary action, while at the same time the ability of the soil to return the water to the surface will be reduced to the minimum, and if a good mulch is now added the water will be under the best conditions for being used by the tree. So, too, if the soil about the roots of transplanted trees is well firmed to insure the rapid transit of water to them, while the surface is left loose and well mulched at the time of setting to prevent capillary action upward above the roots and to permit the rains to penetrate downward to them, we start the trees under the best possible conditions for growth, so far as moisture is concerned. * * *

The practical deductions of the author as regards the use of tillage implements are as follows:

A tool like the disc harrow, or like the curved-toothed harrows, which cuts narrow and comparatively deep grooves in the soil, leaving undisturbed ridges between them, tends to dry the ground rapidly and deeply.

Tools like the plow and some forms of cultivators, which cut the whole surface of the ground, leaving a loose layer of soil on the top, tend to dry the loosened soil, while the loss of moisture from below by capillary action and evaporation is diminished.

Deep plowing in the spring, especially if the soil is heavy and if coarse material is turned under, would tend, unless prevented by early, heavy rains, to produce a deficiency of moisture for shallow-rooted plants and for deep-rooted plants during the early part of the season, by partially cutting off the water supply at a depth below the roots.

Shallow plowing or surface stirring would tend to diminish surface evaporation, and at the same time allow capillary action to lift water from below to the roots of young and shallow-rooted plants.

Fall plowing and early spring treatment with tools like the disc harrow would tend to draw the water to the surface with the minerals held in solution, and thus concentrate the fertility at the surface for later use, thus preventing so much being lost by underdrainage.

The more recent work of this investigator on the influence of deep and shallow cultivation on the water content of the soil indicates that—

(1) Thorough cultivation greatly diminishes surface evaporation from the soil.
(2) Thorough cultivation keeps the soil below the surface cooler, and this materially strengthens the capillary power so that less water percolates downward out of the reach of root action.
(3) The capillary force being stronger the soil moisture is moved upward faster and through longer distances as the roots of growing crops consume it, and thus more water becomes available.

The question of the amount of water required to produce a pound of dry substance in various farm crops, both under natural and artificial conditions, has also been studied by King during a number of years. The results obtained "point very strongly toward the conclusion that we rarely have water enough in our soils under natural conditions to realize even approximate possible returns from our land, and that were we prepared to irrigate almost any of our crops at such times as there is a deficiency of water in the soil, very much larger average yields would be secured."

POTATO SCAB.

The independent and simultaneous investigations of Roland Thaxter, of the Connecticut State Station, and L. H. Bolley, of the North Dakota Station, on the cause of potato scab and the treatment for its prevention, gave very important results as indicated in the following summary.

The well-known condition of potatoes designated as scabbed is caused by the tuber forming a more or less regular layer of cork cells to protect itself against the irritating influence of a fungus parasite. The scab fungus, known scientifically as *Oöspora scabies*, enters the growing tuber in the form of minute filaments or threads, surrounding, penetrating, and filling the outer cells of the potato, especially the newer growth, usually killing them. The underlying cells, in order to protect themselves against the irritating presence of the fungus, form thick cork-like cells in several layers. By the growth of the tuber and constant attack of the parasite this layer becomes cracked, rough, and irregular. The fungus seems to flourish best in a rather heavy soil containing a considerable quantity of organic matter, and it has been repeatedly demonstrated that it can remain in the soil for several years, living on the decaying organic matter, yet capable at any time of attacking a crop of potatoes, beets, and possibly other root crops. The fungus first appears on the tubers as a peculiar, delicate, grayish mold, which is especially abundant on the newer growth. It spreads rapidly and will soon infest the whole hill.

Recent experiments tend to show that the fungus will grow most rapidly and abundantly in a neutral or slightly alkaline soil. Such conditions are found where lime, ashes, or stable manure is added to the soil. The lime and ashes supply directly the alkaline conditions, and the stable manure, through the formation of ammonia and various carbonates, has the same effect. In this way may be explained the fact, often observed, that adding lime or ashes to the soil increases the scab. Experiments conducted at the Rhode Island Station on soil known to be acid in its reaction, fully demonstrated that while the addition of lime, ashes, or stable manure increased the total yield, it increased the amount of scab in a still greater ratio.

The loss caused by the scab fungus is very difficult to estimate, as it seldom renders the whole crop unmarketable. Estimates have been given for North Dakota, Michigan, New York, and other States, show-

ing that from 20 to 60 per cent of the crop is affected to some degree, and the actual loss is placed at from 3 to 20 per cent of the entire crop.

The disease may be spread in various ways. Planting of scabby seed or in infested soil will give a scabbed crop. Stable manure containing the droppings from animals fed on the refuse of potatoes, beets, or other root crops is liable to be a source of infection, as it has been well established that the fungus will pass unimpaired through the alimentary canal of animals. To remove this source of infection all potatoes and roots fed to stock should first be thoroughly and properly cooked. Surface water should not be permitted to drain from infected soil to that free from the scab, and attention should be paid to cleaning plows and all cultivating apparatus when passing from one field to another. By observing these precautions not only will a clean crop be assured but the soil will not become infested. If clean seed be planted in clean soil a clean crop will be secured. It has been learned that by the use of the proper chemicals even scabby seed may be rendered nearly powerless to spread the disease. Different methods of treatment have been suggested, but perhaps the best in respect to efficiency, cheapness, and convenience is that of treating the seed potatoes before planting with a solution of corrosive sublimate (mercuric chloride).

The method of treatment consists in soaking the seed for one and a half hours in a solution of 2¼ ounces of corrosive sublimate in 15 gallons of water. If the potatoes are dirty they should be washed before being placed in the solution of the fungicide. After the soaking the potatoes should be spread so as to dry quickly. The treatment may be performed at any convenient time, and the potatoes may be cut either before or after treatment. The action of this chemical is sufficient to destroy the fungus, but if used as recommended will not injure the growth of the potato. Enough of the chemical to treat 30 to 40 bushels need not cost more than 50 to 75 cents. It is a very powerful poison and should be handled with care, none of it being taken into the stomach. It is very corrosive to metals and should never be kept in metallic vessels. A cheap and good way of procedure is as follows: Dissolve the corrosive sublimate in 2 gallons of hot water. Pour the solution into an open-headed barrel or hogshead and add 13 gallons of water. Place the potatoes in a loosely woven sack—a coffee sack is very good for this purpose—and dip the whole into the solution, allowing it to remain for an hour and a half. The solution should be stirred from time to time to keep it well mixed.

If seed potatoes are treated as above and then planted in soil free from the scab, and if no manure from stock fed on scabby potatoes is used, a clean crop may be expected. But if the soil is contaminated no kind of treatment will be of any considerable benefit. How long the fungus can remain in the soil is not known, nor is there any definite means for ridding the soil of it. Probably a rotation of crops will finally starve it out. Grasses, corn, and wheat are probably not affected by this fungus and should be used in the rotation, but not beets or other root crops.

The potatoes should be dug as they mature and stored in a dry place. This will prevent further development of the scab fungus if it should be present, and thus reduce the loss due to this cause.

BEAN ANTHRACNOSE.

This disease, to which beans are very susceptible, has been the subject of investigation at several of the experiment stations, notably the New Jersey and New York Stations. It is caused by the fungus *Colle-*

totrichum lindemuthianum. In New York it is estimated that at least 5 per cent of the growing plants are destroyed every year, and the total loss is still greater, due to the inferior crop produced by the diseased plants.

The disease seems to affect all parts of the plant. If diseased seed is planted, the infection may be often found upon the first leaves (cotyledons) as soon as they push through the ground, or it may appear upon the young stalk where it often eats its way through the stem, destroying the young plant. In this way often 25 to 50 per cent of the young seedlings and germinating seed may be destroyed.

Upon the plants surviving the first attack, the disease continues its depredations on the stems and foliage, spotting and pitting them, often causing a serious dropping of leaves and leaflets. Upon the leaves the fungus seems most frequently to attack the veins, which turn black, especially on the under side of the leaf. Once established upon the leaf, it may appear between the veins, forming narrow, irregular, elongated dark spots that soon break away, leaving irregular cracks in the leaf. When the foliage is injured to any considerable extent by this disease the yield of beans is materially reduced.

Upon the pods the presence of the disease may be known by the appearance of black or brown pits with red borders. At first these spots are circular in outline, becoming enlarged and irregular through the coälescence of several spots. When along the edge of the pod, the disease may be seen as narrow strips of dark color. Soon after the formation of a spot, there appear in its central portion pink spots, which consist of spore masses, pushed out by the fungus for its spread to other hosts. Its attacks upon the pods prevent them from filling perfectly, if they fill at all. The disease may spread in the market, where it may suddenly appear upon snap beans and spreading to others ruin them before they reach the consumer.

Upon the seed the presence of the disease is indicated by the production of pits, specks, wrinkles or blisters, and discolorations of various kinds. It has been repeatedly demonstrated that such seed as has just been described can carry the spores of disease over from one season to another.

In seeking to prevent this disease the first precaution is to see that the seed is not affected when planted. If a comparatively small amount of seed is to be planted, the careful selection of the beans by rejecting all discolored, cracked, wrinkled, or otherwise unsound seed will fully repay its cost. If no infected seed was planted, loss from anthracnose would be unknown. As an additional precaution, or where large quantities of seed make the careful inspection impracticable, the seed may be treated in such manner as to destroy the fungus secreted within or upon it. Soaking the seed for an hour in a solution of strong ammoniacal carbonate of copper, composed of 3 ounces of carbonate of copper, 1 quart ammonia, and $4\frac{1}{2}$ gallons water, has given good results. Treating the seed for fifteen minutes with hot water at 120° F., or five minutes at 130° F., will give a crop containing a greatly reduced percentage of diseased pods, although the germinative ability of the seed is sometimes lowered by the treatment. Whenever treated seed is used, a sufficient quantity should be planted to make up for any injured by the treatment.

The most effectual treatment consists in spraying the diseased plants with Bordeaux mixture made by the following formula: Copper sulphate (blue vitriol) 2 pounds, freshly slaked lime $1\frac{1}{3}$ pounds, water 30 gallons, to which is added enough soap to make a good suds, enabling

it to spread over the foliage to a greater degree. If the soap is not used, only about 22 gallons of water should be taken. In spraying, a good nozzle is needed, that the solution may be well distributed. The mixture must be kept well stirred, as it settles very rapidly. This solution does not kill the fungus in diseased plants, but prevents its spreading to those not affected.

The time of spraying and number of applications can not be definitely prescribed, as various conditions must be considered. The first application should be given as soon as the plants are well through the ground and their first leaves spread, care being taken to cover every part of the plant. A second spraying should follow in a week or ten days, with a third or fourth as may be required by the symptoms as already given. If rainy weather follows a spraying, another should be given as soon as possible to take the place of that which may have been washed away. Field beans usually require but three sprayings, while perhaps four should be given snap or string beans. Numerous experiments made with Bordeaux mixture at the New York State Station gave increased yields, as to the number and weight of pods, of from 30 to 60 per cent in favor of spraying. The cost of the chemicals is small and the application is the chief item of expense. No danger need be apprehended from the presence of the blue vitriol upon the pods intended for snap beans, as the amount of the copper compound will be so small as to be entirely harmless. In applying the solution any sort of spraying pump may be used, the nozzle being the most important part of the apparatus, as a uniform spray must be thrown.

CRIMSON CLOVER.

This clover has been investigated and reported on by the California, Delaware, Maryland, New Jersey, North Carolina, and other stations.

Crimson clover (also known as scarlet, German, or Italian clover) bears a resemblance to the common red clover, from which it is easily distinguished by the greater length of its flower spike, which is from 1½ to 2 inches long; by the bright crimson color of its flowers; and by differences in the shape and marking of the leaflets. Crimson clover is an annual plant growing to about the same height as red clover. Though not generally grown far north, it attained a height of 26 inches at the Maine Station when sown in the spring. It has, under certain conditions, some advantages over red clover, in that it flourishes on relatively poor soils. It grows during the late winter and spring and blooms so early in the spring as to allow other crops to occupy the land in the same year. At the California Station crimson clover was successfully grown in temperatures which checked the growth of alfalfa. In the South it is grown on noncalcareous, sandy, or clay soils. It affords early spring pasture and a good quality of hay, and has much value as a green manure for light soils. Good silage has been made from crimson clover. This plant is largely used in Delaware as a green manure for orchards, and has been found valuable in protecting and keeping clean apples blown off by wind. The Maryland Station recommends crimson clover as suitable for supplying green food for poultry in winter, and the Delaware Station commends it as a food for bees.

As a feeding stuff.—Analyses made at the New Jersey Station give to crimson clover hay a high feeding value, and experiments at the North Carolina Station show a higher rate of digestibility for the pro-

tein and carbohydrates of crimson clover than for the same constituents of red clover hay. A ton of crimson clover hay contained the following amounts of digestible nutrients: 19 pounds of fat, 240·4 pounds of fiber, 185 pounds of protein, and 525·6 pounds of carbohydrates. A ton of crimson clover hay contained 55·4 pounds more of digestible protein, and about the same quantity of the other food ingredients as there was in a ton of red clover hay. The richness of the crimson clover hay in protein especially fits it for feeding in connection with such poorly balanced foods as straw, cotton-seed hulls, and corn stover.

As a green manure.—For green manuring the value of crimson clover is high. Analyses made at the New Jersey Station gave 2,350 pounds per acre as the amount of organic vegetable matter contained in the plants and roots of crimson clover where the crop amounted to 5 tons of green clover per acre. This green manuring afforded 61·5 pounds of nitrogen, 12·6 pounds of phosphoric acid, and 52·8 pounds of potash per acre, or as much organic matter, nitrogen, and potash as is supplied by 7·5 tons of average stable manure.

A crop of crimson clover turned under has been found to be an excellent substitute for nitrate of soda in growing sweet potatoes in Delaware. Orchards on thin soils may be benefited by plowing under crimson clover for several years in succession. It is stated that the plants when turned under decay more rapidly in the soil than red clover, leaving the land in good condition for future crops.

Culture.—In Delaware crimson clover is sown the latter part of July or during August. In the South seed may be sown from August to the middle of September, or even later in extreme southern latitudes. It is important that considerable growth should be made before winter. On the other hand, to obtain a good stand one must wait for a suitable season. Crimson clover should not be sown in the fall with a crop of winter grain. The quantity of seed varies from 10 to 15 pounds per acre sown broadcast. It is not necessary to prepare the land especially for the clover crop, but the seeds may be sown in fields of cotton, corn, or vegetables immediately after the last cultivation and without covering. If clover is the only crop a little brushing or rolling is in order. On stubble land a catch may be secured by harrowing deeply and then sowing the seed and rolling or harrowing lightly. The seed may also be sown among the vines of the cowpea crop. The clover begins to grow as the peas die, and these two renovating crops supply a very large amount of organic matter to the soil. Failure to secure a stand of crimson clover is frequent, due sometimes to the seed and sometimes to the season. The newly germinated plants are easily killed by a scorching sun.

In Delaware crimson clover may be cut for hay or for silage early in May. In the South it blooms in April. A yield of from 1 to 2 tons of hay per acre may be secured from very thin land. The hay is taken off in time to allow the use of the field for other summer crops, such as cotton, corn, or vegetables. In Delaware some farmers when plowing under the green crop in orchards so turn the furrows as to leave the heads of clover above ground. These heads bear seed, and thus afford a stand next year. In cutting for hay in orchards other farmers leave strips of uncut clover along the rows of trees, from which the seed is scattered for the next year's crop.

In brief, crimson clover has proved a valuable plant for green manuring, for hay, and for other purposes on light soils in Delaware, New Jersey, the Southern States, California, and elsewhere.

SOJA BEANS.

These beans are also known as soya and soy beans. Two distinct species have been called by these names. The small bean (*Phaseolus radiatus*) is largely used in Japanese confections, but is of no special value as a forage plant.

The large bean (*Soja hispida* or *Glycine hispida*) is the true soja bean, and has been found by the stations in a number of States to be a valuable forage plant. In Japan this bean is largely used as food for man and animals.

The soja bean is an annual leguminous plant, resembling the bunch or upright varieties of cowpeas. The growth is erect and from 3 to 4½ feet high. The short pods are borne thickly on the stocky, bushy plant. Stems, leaves, and pods are densely covered with short hairs.

The soja bean can not be said to be a new plant in the United States but was introduced from Japan before the organization of the experiment stations in 1888. However, the varieties first introduced were too late in maturing for localities in which early autumn frosts occur. The Massachusetts State Station and the Kansas Station introduced from Japan early varieties of soja beans. Repeated experiments at these stations indicated that these matured in Massachusetts with the same certainty as the common varieties of corn, and that they ripened in Kansas in any season. The varieties which experiments have shown to be early enough for Kansas are Eda-mané, Yellow Soy, Yamagata Cha-daidzu, and Kiyusuké Daidzu. In Kansas soja beans have shown considerable ability to resist drought.

The seed should be planted only after the ground is warm in the spring. In Kansas the latter part of May is the preferred season. The beans, at the rate of 5 to 10 per foot, are planted in drills from 2½ to 3 feet apart. The cultivation is similar to that given the bunch varieties of the cowpea and should not occur while the leaves are wet with dew or rain. The vines are cut when the beans begin to ripen, cured in small, high piles, and threshed when dry.

At the South Carolina Station the yield of beans was from 10 to 15 bushels per acre. At the Georgia Station soja beans yielded 1,307 pounds of beans per acre, while the yield of cowpeas on an adjacent plat was only 840 pounds. The weight of dry forage from the former was also greater than that of the hay from cowpeas. At the Massachusetts Hatch Station the variety Medium Early White soja bean yielded at the rate of 35 bushels per acre. The variety Black Medium made a ranker growth of vine than most of the other sorts. At the Massachusetts State Station soja beans yielded 5,949 pounds of dry mattter per acre. The red varieties have been found superior to the white in productiveness and in beauty of appearance.

At the Georgia Station soja-bean forage was relished by stock and was more easily cured than cowpea vines. The yield of soja-bean forage, exclusive of beans, was at the rate of 2,940 pounds of dry matter per acre, containing 88·2 pounds of crude fat, 438·06 pounds of crude protein, 730·29 pounds of fiber, 1,143·36 pounds of nitrogen-free extract, and 186·39 pounds of ash. Analysis showed the beans to be much richer than cowpeas in protein and fat but poorer in starchy matters. One hundred pounds of air-dry beans contained 20·48 pounds of crude fat, 35·24 pounds of crude protein, and 25·86 pounds of nitrogen-free extract. The nutritive ratio is very narrow. This very high percentage of fat and protein makes soja beans a suitable substitute for cotton-seed meal and linseed meal and other concentrated and costly feeding stuffs

which dairymen often find it necessary to purchase. Soja-bean meal without any admixture was relished by milk cows at the Massachusetts Hatch Station.

The soja-bean plant has been advantageously used for hay, for soiling, and for silage, and is believed to have, in common with most cultivated leguminous plants, the power of obtaining some of its nitrogen from the air, and hence of acting as a soil renovator.

MELILOTUS.

Melilotus (*Melilotus alba*) is also known as Bokhara clover, sweet clover, and large white clover. In the appearance of its leaves there is a general resemblance to the clovers. It grows much taller (3 to 8 feet) and bears a number of small white flowers on a spike-like raceme. It is a biennial, but will reseed itself indefinitely.

Uses.—Melilotus is valuable both for pasturage and for hay. At first animals refuse to eat it, but later relish it. It makes an early spring growth and remains green late in the fall.

On the lime lands of the South, for early and late pasturage and for restoring the fertility of exhausted fields, it is equal or superior to any of the clovers. When cut early it is a valuable hay crop, but in this respect is surpassed by lespedeza and red clover. Though melilotus grows on lime soils North and South, it has been appreciated chiefly in the South. In some States farther north it is considered a weed. As a renovating crop it merits trial on calcareous soils in every latitude. Melilotus has also some value as a bee plant.

Soils.—Melilotus thrives on calcareous soils, making some growth even on the bare rotten limestone where no other plant could subsist. On the black prairie soils of the South and on yellow loam and white lime soils it has a high value as a renovating crop. The black prairie soils, most of which do not respond to commercial fertilizers, are easily improved by seeding to melilotus. The decay of the large roots not only supplies plant food, but by leaving numerous small holes in the soil aids in the drainage.

The most favorable reports come from the Mississippi and Alabama Canebrake Stations, where the land is highly calcareous. At the Mississippi Station it thrives best on soil richest in lime, where the rotten limestone is near the surface, making less thrifty growth on clay hills and rich bottoms.

Culture.—February and March are the best months for sowing. From 2 to 4 pecks of seed per acre should be sown broadcast. A smaller amount of seed will give a smaller crop the first year, but will suffice if the plant is allowed to reseed itself. Sow the seed on well-prepared land and the rains will cover it; or, if the land is not in good condition, harrow after sowing. Melilotus may be sown with oats in February, or the seed may be scattered over a field of fall-sown oats.

Harvesting.—During the first season, one or two cuttings may be made; during the second season two or three. If the land is to remain in melilotus more than two years, only two cuttings are made the second season, after which there is usually sufficient seed formed to insure a stand. It is important that melilotus be cut before the stalks become coarse and woody. From 15 to 20 inches is the best height. The first cutting of the second season is secured about May 1. Melilotus produces a heavy growth of hay, which, though excellent for home use, is not as salable as lespedeza hay.

Melilotus must be cured with care, as too much sun causes shedding

of the leaves. At the Massachusetts State Station it produced at one cutting 3,090 pounds of hay per acre the first season. Its yield is much heavier the second season.

At the Pennsylvania Station the yield of dry matter on the best portion of the experiment plat was at the rate of 4,499 pounds per acre, containing when cut before bloom, August 2, 2,265 pounds of nitrogen-free extract and 521 pounds of crude protein per acre. The stems of the plant became woody very rapidly during their development and cattle refused to eat any very considerable quantity of them when fed alone. At the Utah Station melilotus made a very large yield, and the plant seemed especially adapted to the climatic conditions of Utah; but as the crop was not cut until 55 inches high it was not suitable for feeding.

Rotation.—Corn, cotton, and oats all succeed well on a field that has been in melilotus two years. Such a rotation sometimes increases the corn crop from 10 or 15 to 25 or 30 bushels per acre and upwards. When it is desired to keep the land in melilotus more than two years, seeds must be allowed to form, and these must be left as they fall, or the land may be harrowed.

At Columbus, Ohio, a piece of land which in July, 1888, had been sown in melilotus and on which this plant was allowed to grow up and fall down, reseeding the ground, was seeded to wheat in the fall of 1891. A similar adjoining plat which had meanwhile been in cultivation was used as a check. The yield of wheat after melilotus was 26·9 bushels per acre; on the check plat the yield was 18·6 bushels, showing a difference of 8·3 bushels per acre in favor of the plat on which melilotus had been grown. In commenting on this the director of the Ohio Station states that although melilotus is a weed in that State it can be easily controlled.

VETCHES.

Vetch is the name properly used to designate leguminous fodder plants of the genus *Vicia*, but the term is also applied to kindred plants of other genera. Vetches are tender twining plants, resembling a small pea. It is best to sow the seed with small grain, so that the latter may serve as a support for the slender vines. The seed may be sown broadcast or in drills. Vetches are rich in protein and hence rank high in feeding value. Since they belong to the class of plants of which many species are known to acquire a part of their nitrogen from the atmosphere, vetches are also esteemed as soil renovators. Moreover, experiments in Europe have shown that a winter-growing plant utilizes the valuable nitrates which, on a bare soil, would be washed out by winter rains and wasted. Hairy vetch (*Vicia villosa*), which is a winter-growing plant, seems well adapted to this use. Hairy vetch and common or spring vetch (*Vicia sativa*), are the most important kinds tested by the American experiment stations.

Spring vetch.—The spring vetch begins to grow late in winter or early in the spring. At the Nebraska Station this species sown April 25 blossomed June 27. It grew about as large as red clover, with which it compared very favorably as a forage plant. It remained green late in the autumn.

At the Connecticut Storrs Station 2 bushels of vetch seed with 1 bushel of oats per acre sown broadcast gave a yield of 8·6 tons of green forage. At the Massachusetts State Station spring vetch proved to be one of the earliest annual legumes; in Oregon it produced a

large amount of forage which was relished by stock. At Grayling, Michigan, the young plants were easily killed by frost.

Hairy vetch.—The hairy, or Russian, vetch is, as its name indicates, a densely hairy plant. In Europe this species has proven especially valuable on account of its hardiness and its ability to yield a large amount of forage on sandy soil. It proves resistant to cold and to drought in central and northern France, where it is sown the latter part of August, and yields two cuttings the next spring. The director of the Seed Control Station of the Agricultural Institute of France recommends it for all soils except those which are calcareous or very wet. At the Nebraska Station hairy vetch made a good growth and proved hardy under heat, cold, and drought.

In Mississippi hairy vetch sown early in the fall makes a dense growth by February and continues to grow until hot weather. It bears grazing well and is relished by stock. For the Gulf States this is considered the most valuable species.

On clay soil at the Pennsylvania Station the seed was drilled May 20 and the plants bloomed until frost. The yield was 14,520 pounds of fresh, or 4,877 pounds of dry matter per acre, containing 2,122 pounds of nitrogen-free extract, 598 pounds of protein, 125 pounds of fat, 1,262 pounds of fiber, and 507 pounds of ash. In this experiment vetch yielded about the same amount of protein per acre as red clover and much more starch and woody matter. "Our experience here seems to indicate that if the vetch were sown with a stiff-strawed crop, such as oats, which would prevent it from trailing upon the ground, it might be profitably used as a soiling crop in the interval between the blossoming of red clover and the time when soiling corn has reached a development great enough to warrant its being fed."

FLAT PEA, OR LATHYRUS SYLVESTRIS.

This perennial leguminous plant in its wild state contained large percentages of gentianin and tannin, which were injurious to stock. It is claimed that by careful cultivation in Europe this dangerous quality has been totally eliminated. This forage plant has attracted much attention in Europe, and in recent years has been brought to notice in the United States. The claim is made that it thrives on drifting sands, that it occupies the land without reseeding for as long a time as fifty years, and that it yields a large amount of very nutritious forage.

At several of the American stations the flat pea is now under investigation, and preliminary reports have been made by the Michigan, Virginia, California, Louisiana, and other stations. The fact that the plant requires several years' growth to give the best results prevents at this time a statement of its true worth for this country. In the coast region of California it grew vigorously throughout the dry season. In Louisiana, at last accounts, it was growing moderately well. At the Michigan station it was unhurt by the cold of winter, and plants transplanted when one year old to a sandy soil gave a yield at the rate of 10,460 pounds of green forage per acre. This forage was readily eaten by cattle in Michigan, but at Ottawa, Canada, cattle and horses refused to eat flat pea forage.

Analyses of plants grown in Virginia and cut when the ripe pods were on the vines showed in every 100 pounds of dry matter 18·75 pounds of crude protein, 35·71 pounds of nitrogen-free extract, 34·9 pounds of fiber, 3·72 pounds of fat, and 6·92 pounds of ash.

The Virginia Station called attention not only to the advantages claimed for *Lathyrus sylvestris*, but to the admitted disadvantages, which are the difficulty of eradication, the length of preparatory growth, and slowness in germinating.

It would be well for farmers who are interested in the flat pea to await further reports from the stations now experimenting with this plant before arranging to grow any large area.

FERTILIZER EXPERIMENTS ON TOMATOES.

In a number of States the tomato has become an important crop. According to a recent estimate there were canned in the United States in 1892, 3,223,165 cases of tomatoes, each case containing two dozen cans. In the State of New Jersey alone the estimated area of tomatoes grown in 1889 for canning and for the general market was 17,000 acres, worth more than $1,000,000. The value of the tomato crop in Virginia in 1889 was estimated at $1,000,000.

To aid this important industry the experiment stations in a number of States have made experiments with a view to increasing the yield of tomatoes and augmenting the profits of the tomato-grower. These investigations have embraced studies of injurious insects and of diseases, and tests of methods of transplanting, culture, training, and manuring.

The effect of fertilizers on tomatoes has been investigated by the Delaware, Georgia, Maryland, New Jersey, New York (Cornell), Tennessee, Virginia, and other stations. Most of these tests indicate that nitrate of soda is a fertilizer especially suited to the tomato.

At the Maryland Station, while nitrate of soda increased the crop of tomatoes the use of dried blood was not profitable. Nitrogen, in the form of nitrate of soda, proved the best single fertilizing element; potash, in the form of muriate, standing next in value.

In New Jersey in 1889 the use of 80 pounds per acre of nitrate of soda in one application and of 160 pounds in two applications increased the yield without delaying the maturity of the tomatoes; 160 pounds per acre in one application also increased the yield, but at the expense of maturity. The yields of tomatoes on different plats were increased by 35 to 60 per cent from the use of nitrate of soda. In every case there was a large profit from its use, ranging from $17 to $33 per acre. In these experiments it was also noticed that the use of nitrate of soda and of barnyard manure resulted in a more solid tomato with less seeds than when potassic or phosphatic fertilizers, or no manure was used.

In 1890, in a peculiarly unfavorable season, nitrate of soda on one farm did not increase the yield over the unfertilized plat; one and two applications gave practically identical results. However, on the farm used for the experiments of 1889 nitrate of soda in 1890 was the most effective fertilizer tested.

In 1891 on a fertile sandy loam soil the best results were from the use of nitrate of soda alone. On another farm, on a light clay loam, which had received little manure in previous years, nitrate of soda alone was not profitable.

The average results secured in experiments during three years seemed to warrant the conclusion that with good cultivation and previous liberal manuring the application of 160 pounds per acre of nitrate of soda alone would be uniformly more profitable in New Jersey for early tomatoes than combinations of minerals, barnyard manure, or a complete fertilizer.

On the other hand, in Delaware nitrate of soda was unprofitable as a fertilizer for tomatoes, which, however, seemed attributable to the fact that on the experimental plats a sod of alfalfa and clover had been plowed under the previous year and had supplied a large amount of nitrogen to the soil.

In Virginia nitrate of soda alone did not increase the yield of tomatoes, but a combination of this material with mineral fertilizers applied soon after transplanting to the field increased the yield and improved the quality of the product.

Experiments at the New York Cornell Station indicated that nitrate of soda should not be used alone for tomatoes on *poor* soil, but should be combined with phosphatic and potassic fertilizers. However, on good soil nitrate of soda alone increased the yield. "Tomatoes need a fertilizer which is quickly available early in the season. Fertilizers applied late, or which give up their substance late in the season, give poor results, because they delay fruitfulness and the plant is overtaken by frost before it yields a satisfactory crop. This fact is no doubt the origin of the widespread notion that the tomato crop is injured by heavy manuring." Experiments continued for several years at this station contradict the common notion that heavy manuring lessens the productiveness of the tomato, and the results indicate that good stable manure in abundance can be used profitably on tomatoes.

In Georgia, on a poor soil, a complete fertilizer was required for tomatoes. Superphosphate increased the earliness of the crop, a point of much importance with tomatoes grown for market. Very heavy applications of nitrogen, especially in the form of cotton-seed meal, prolonged the time of bearing.

In Tennessee liquid manure proved unprofitable on tomatoes.

Experiments made at the Maryland Station emphasized the fact that it is not profitable to grow tomatoes on the same soil year after year, and these experiments, with numerous others, indicate that liberal manuring is profitable for tomatoes.

The fertilizing ingredients removed from the land by a crop of 10 tons of fresh tomatoes were determined by the Maryland station to be as follows: 31·9 pounds of nitrogen, 9·2 pounds of phosphoric acid, and 53·8 pounds of potash. These quantities of nitrogen and of phosphoric acid are nearly the same as would be removed by 25 bushels of wheat, but the crop of tomatoes removed about six and a half times as much potash as would the crop of wheat.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories. Alaska is the only section of the United States which has no experiment station. The station in Montana was established during the past year. It is located at Bozeman as a department of the Montana College of Agriculture and Mechanic Arts. In each of the States of Alabama, Connecticut, Massachusetts, New Jersey, and New York a separate station is maintained wholly or in part by State funds, and in Louisiana a station for sugar experiments is maintained mainly by funds contributed by sugar planters. In several States substations have been established. Excluding the branch stations the total number of stations in the United States is 55. Of these 49 receive the appropriation provided for in the act of Congress above mentioned. The total income of the stations during 1893 was $950,073, of which $705,000 was

received from the National Government, the remainder coming from State governments, private individuals, fees for analyses of fertilizers, sales of farm products, and other sources. In addition to this the Office of Experiment Stations has an appropriation of $25,000 for the current fiscal year. The value of additions to equipment in 1893 is estimated as follows: Farm implements, $8,380; buildings, $59,578; libraries, $11,216; apparatus, $17,672; live stock, $7,085; miscellaneous, $29,927; total, $133,858.

The stations employ 532 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 70; chemists, 119; agriculturists, 54; horticulturists, 62; farm foremen, 25; dairymen, 7; botanists, 37; entomologists, 42; veterinarians, 26; meteorologists, 13; biologists, 11; physicists, 4; geologists, 4; mycologists and bacteriologists, 5; irrigation engineers, 4; in charge of substations, 33; secretaries and treasurers, 25; librarians, 8; and clerks, 27. There are also 25 persons classified under the head of "miscellaneous," including superintendents of gardens, grounds, and buildings, apiarists, herdsmen, etc.

During 1893 the stations have published 48 annual reports and 298 bulletins. Besides regular reports and bulletins a number of the stations issued press bulletins, which are widely reproduced in the agricultural and county papers. The mailing lists of the stations now aggregate about half a million names. Correspondence with farmers and calls upon station officers for public addresses at institutes and other meetings of farmers are constantly increasing. The station officers have contributed numerous articles on special topics to agricultural and scientific journals. They were also called upon to render important and laborious services in connection with the preparation of exhibits illustrating agricultural progress made by the different States at the World's Columbian Exposition. The prominent part assigned to station workers in connection with the great test of dairy breeds at the Exposition is a gratifying evidence of confidence in the stations on the part of great agricultural interests.

A million dollars are now annually expended in the United States in experimental inquiries in agriculture. Three-quarters of this large sum comes from the national treasury. While this is a much larger aggregate expenditure for this purpose than has ever been made by any other nation, it involves the use of only 30 cents for each $1,000 of our annual agricultural product in an attempt to improve the quality and quantity of that product. From this point of view the resources of our stations can not be deemed unreasonably large, especially when we consider the wide diversification of our agriculture even under present conditions and the great need for more rational and profitable methods of farming. On the other hand, the annual expenditure of so vast a sum from the national treasury can not be justified unless the institutions conducted under this grant show a keen appreciation of their responsibility to make a wise and economical use of the funds intrusted to them by the people.

In considering the operations of the experiment stations it is important to have a clear understanding of their relations to the system of industrial education of which they constitute an important branch, and to the Government of the United States from which they derive most of their financial support.

By an act approved July 2, 1862, Congress gave to each State 30,000 acres of public land for each Senator and Representative for the endowment of colleges, " where the leading object shall be, without excluding

other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

The moneys derived from the sale of the land must be invested so as "to constitute a perpetual fund" which the State must keep "forever undiminished," except that 10 per cent of the amount received by any State "may be expended for sites or experimental farms." No portion of the fund nor the interest thereon can be spent for buildings.

The institutions which are receiving the benefits of this act are so varied as to defy classification. Some are purely agricultural colleges, others are appropriately called colleges of agriculture and mechanic arts, others are universities with departments of agriculture and mechanic arts, and a few do not differ materially from the colleges for general education in science and liberal arts. These institutions have provided free tuition to thousands of the sons and daughters of farmers, mechanics, and others belonging to the so-called "industrial classes." As the demand for technical education in agriculture and the mechanic arts has increased they have added to their facilities for instruction in these lines. In quite a number of these institutions provision has been made for technical instruction, especially in agriculture, ahead of the demand, and the great problem still before these colleges is how to get students in agriculture and other industrial courses. While the grade of instruction offered is quite varied in the different institutions, it must be remembered that the act of Congress under which their industrial courses are conducted requires them to be "colleges" which shall promote liberal as well as practical education.

In 1890 Congress again came to the aid of these institutions by passing an act that provides for an annual appropriation out of money arising from the sale of public lands. This appropriation was fixed at $15,000 for each State and Territory for the year ending June 30, 1890, with an annual increase of $1,000 a year for ten years, after which the yearly stipend will be $25,000. This money shall "be applied only to instruction in agriculture, the mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic science, with special reference to their applications in the industries of life, and to the facilities for such instruction."

The Secretary of the Interior is "charged with the proper administration of this law," with power to withhold appropriations subject to an appeal to Congress. The presidents and treasurers of the colleges are required to make annual reports to the Secretaries of Agriculture and the Interior.

Meanwhile, in 1887, Congress had passed an act for the establishment of agricultural experiment stations. By this act $15,000 per annum is "appropriated to each State" and Territory "out of any money in the Treasury proceeding from the sales of public lands," "for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results." The stations, with a few exceptions defined in the act, are required to be departments of the colleges established under the land grant act of 1862.

"The grants of money authorized by this act are made subject to the legislative assent of the several States and Territories," and are to be paid quarterly "to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same." "Whenever it

shall appear to the Secretary of the Treasury from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station." It is the duty of each station to make annually to the governor of the State or Territory and to the Secretaries of Agriculture and the Treasury "a full and detailed report of its operations, including a statement of receipts and expenditures."

It will be observed that the stations are entirely under the direction of the governing boards of the colleges, and that no provision is made for an accounting to the governments of the States or the United States except in so far as this may be provided for in the States by the statutes under which the colleges are conducted or be required by the Treasury of the United States to determine whether there is an unexpended balance of the annual appropriation to the stations.

The relations of the land-grant colleges and agricultural experiment stations to the U. S. Department of Agriculture are very generally misunderstood. The act of 1862, by which the colleges were established, makes no mention of this Department, which was created the same year. The act of 1890 for the further endowment of these colleges requires that the annual reports of the presidents and treasurers of those institutions shall be made to the Secretary of Agriculture, but he is not authorized to take any part in the enforcement of the act.

The act of 1887 establishing the stations provides for annual reports to the Secretary of Agriculture, but he is not authorized to exercise any control over the operations or expenditures of the stations. He is simply required to render the stations assistance, as indicated by the following language of the act:

> In order to secure as far as practicable uniformity of methods and results in the work of said stations, it shall be the duty of the U. S. Commissioner of Agriculture to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate, from time to time, such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purposes of this act.

Under this provision of the act the Office of Experiment Stations has been in operation since 1888.

The experiment stations are therefore parts of independent State institutions, each doing its work according to the views of its own officers regarding the requirements of the act of Congress. The U. S. Department of Agriculture is working in its own way to promote the interests of the stations and give the results of their work to the people of the whole country, without authority to direct the operations of the stations or even to restrain them in case they waste or misapply public funds.

The efficiency of the stations organized under the act of Congress of 1887 has in general corresponded with that of the institutions with which they have been united, and the faithfulness with which they have worked has been in proportion to the intelligent interest taken in them by the leaders in agricultural progress in the communities where they are located.

Undoubtedly the difficulties connected with such rapid expansion of experiment station work as has occurred in this country during the past five years were not fully appreciated when the act of Congress creating them was passed. The success of the stations established prior to that act had been so marked and the necessity for researches for the benefit of agriculture seemed so urgent that it was hoped that the establishment of similar stations in all the States would be imme-

diately attended with beneficent results. Experience has shown that much preliminary work was needed in some parts of the country to give the people a just conception of the proper functions of experiment stations, and that the supply of thoroughly trained workers for researches in agricultural science is not even yet equal to the demand.

As regards the advantages which the stations have brought to the farmers, the Director of this office is inclined to agree with those who hold that thus far their most important service has been educational. The station bulletins are now regularly distributed to 500,000 persons who are either farmers or closely identified with the agricultural industry. Moreover, accounts of the station work are given and discussed in thousands of newspapers. The New York Cornell Station alone estimated sometime ago that each one of its publications directly or indirectly reached more than half a million readers. Besides this, hundreds of public addresses are annually made by station officers before farmers' meetings, and the results of station work are taught to thousands of students in the agricultural colleges. Even if the station bulletins recorded only facts well known to scientists and advanced agriculturists, the influence of such a far-reaching system of popular education in agriculture must be very great. So vast a scheme of university extension has never been undertaken in any other line.

The stations have also taught the farmer how to help himself. In a number of lines their work has shown that to be thoroughly successful the farmer must himself be an experimenter, and that the time will never come when rules can be formulated which will do away with the necessity for the exercise of intelligent judgment in the practice of agriculture. This has been notably brought out by the experiments in the use of fertilizers. Hundreds of farmers have already made experiments in coöperation with the stations and have thus learned something about proper methods of experimenting, and have given their neighbors valuable lessons on the way to apply the experience gained by scientific investigators to the peculiar condition of individual farms.

But the stations have also found out some things which are new, and have performed services of great economic value. It is believed that a perusal of the Handbook of Experiment Station Work, above referred to, will amply justify this assertion. In the study of soils and fertilizers; in the tests of new varieties of cereals, forage plants, vegetables, and fruits; in researches on the composition and digestibility of feeding stuffs; in feeding experiments, especially with pigs and dairy cattle; in investigations in dairying, especially regarding means for testing milk and the methods of cheese-making; in observations on plant diseases and injurious insects, and in experiments on the repression of these foes of the farmer, many useful results have been reached.

In general it may be said that the stations are in better condition than ever before to do efficient service for the improvement of our agriculture. Experience has shown the need and value of experimental inquiries in the lines pursued by the stations, and the economic results have been sufficient to justify the continuance and development of these institutions under such conditions as will enable them to do their most useful work.

THE COLLEGES HAVING COURSES IN AGRICULTURE.

In the effort to meet the needs of different classes of farmers the institutions for agricultural education have found it desirable to establish courses of study directly relating to special agricultural industries.

The dairy school connected with the College of Agriculture of the University of Wisconsin has been very successful and is attracting much attention from educators and farmers. On request from this office, Prof. W. A. Henry, dean of the College of Agriculture of the University of Wisconsin, has prepared for this report the following brief account of the origin, growth, and present condition of the Wisconsin dairy school:

THE WISCONSIN DAIRY SCHOOL.

The Wisconsin dairy school, the first of its kind in America, grew out of the belief that we might be of direct and great help to the dairy interests of our Commonwealth. A study of the dairy instruction imparted in Denmark showed that the system there adopted was not suitable for Wisconsin. There students are given the theory of dairying at the school and the practice by placing them one or two in a factory, where they serve an apprenticeship. While many of our factories in Wisconsin were excellently managed, we felt that the student should have actual practice while with us in the manufacture of butter and cheese under skilled instructors. Such a system is very expensive, but no other seemed to meet the situation. In the fall of 1889 we advertised that we would receive dairy students during the winter of 1890, and made arrangements for a small class. Two students registered in this course, and the venture was left in uncertainty at the close of the term. Imagine our surprise the next winter when some 70 applications were received. Our accommodations were entirely too limited, and members of the legislature visiting the school promised us better facilities. The result was the Hiram Smith Hall, named in honor of Regent Hiram Smith, of the State University, who had worked faithfully in the upbuilding of Wisconsin's dairy interests and especially for this school.

This building has a frontage of 95 feet by 54 feet in depth, and is 3 stories in height. In it is an office, a room with lockers where each student's work clothes are kept, bath rooms, a large creamery room, a cheese-making room, one for instruction in farm dairying, a lecture room, and large laboratory. It is planned to accommodate 100 students, beside those taking farm dairying. It cost, with equipment, $40,000. The building is heated by steam and the power furnished by a 25-horse-power engine. The creamery room is 36 by 48 feet in area, with walls of pressed brick and floor of figured tile. Six separators of of the latest pattern stand in line for study and practice. In front of these are the churns, butter-worker, etc. In the cheese room are eight steam-heated cheese vats of 300 pounds capacity, each with its own complete set of cheese-making apparatus. Ample ventilation is provided by forcing air of the proper temperature to each of the rooms by a steam fan.

Let us follow the students in their daily round of duties. Eight o'clock finds 100 students in their seats, each dressed in his snow-white working suit with white cap. At the close of the lecture, fifty minutes in length, one section of the class repairs to the laboratory for drill by a special instructor in milk testing. The second division meets in the creamery where the head instructor calls the roll and assigns to duties. Two additional instructors stand at the separators drilling the squads that meet there. The fourth instructor directs the students at the churn and butter-worker. The third division of the class is met in the

cheese room by 3 instructors, who watch closely, directing each operation.

The term lasts twelve weeks. During this time the student must pass some ten written examinations and several oral ones. He is watched and guided at every point and kept busy all day long. The student who has passed all examinations at the dairy school can become a candidate for a dairy certificate. To secure this he must work in a creamery or cheese factory not less than two full sessions of seven months each, during one of which he shall have entire charge of and be responsible for the cleanliness and success of the factory. He reports the operations of the factory monthly on a blank furnished by the dairy school. His factory is visited by an authorized inspector, and must be found in first-class condition. Filth is costing the dairy business of America millions of dollars annually; no student of our dairy school can receive a certificate whose factory is not neat and tidy in all respects. If the applicant fulfills all the requirements a dairy certificate is issued. At this writing 33 dairy certificates have been granted, with a large number of candidates still working for them. Some of our students are not adapted by nature to pursue dairying as a business; the majority of them are succeeding admirably. In evidence of this, a large number of awards for butter and cheese have been secured by our students at the World's Columbian Exposition.

Thus far nothing has been said of our course in farm dairying. In the dairy school building is one large room devoted to instruction in this line. Here can be found all of the latest forms of hand separators, apparatus for deep setting, small churns, butter-workers, etc. A special instructor is required for this line, his aim being to turn out practical dairymen as required on the farm. These students spend much time in studying the problems of the feeding and breeding of dairy stock, and general farm management.

In all there are required eight lecturers, who give only a portion of their time to instruction in the dairy school, and nine teachers, who give their whole time to instruction in the laboratory and in cheese and butter making. Two tons and a quarter of milk are required daily for the use of the school. The expenses are, of course, very heavy, but the good accomplished is so great that all seem well satisfied.

STATISTICS OF THE COLLEGES HAVING COURSES IN AGRICULTURE.

Under the provisions of the acts of Congress of July 2, 1862, and August 30, 1890, colleges having courses in agriculture are in operation in all the States and Territories. In 14 States separate institutions are maintained for white and colored students. The total number of institutions having courses in agriculture in the United States is 65. The organization of these institutions is so varied that an exact classification of them is impracticable. In a general way, however, they may be classified as follows: (1) Universities having colleges or departments of agriculture; (2) colleges of agriculture and mechanic arts; (3) colleges of agriculture; (4) secondary schools of agriculture. In these institutions the college course in agriculture leading to a degree covers four or in some cases three years. Shorter courses of one or two years, or of a few months, are also provided in many institutions. Special courses in dairying and in other agricultural industries have been recently established at a few of the colleges. Some institutions have preparatory classes in which instruction in agricultural subjects

is given. In a number of States courses of lectures in farmers' institutes held in different localities are given by members of the college faculty during the winter months.

The total number of officers in the faculties in 1893 is 1,282. The total number of students is 17,623, of whom 3,160 are in the courses in agriculture. The graduates from the courses in agriculture in 1893 numbered 265, and the total number of graduates in those courses since the establishment of the colleges is 3,016.

The total revenue in 1893 was $4,024,132, from the following sources: United States (including income of land grant of 1862 and appropriation under act of Congress of 1890), $1,463,215; State, $1,093,870; local communities, $10,003; individuals, $60,906; fees, $301,141; farm produce, $116,625; miscellaneous, $958,372. The value of additions to equipment in 1893 is estimated as follows: Farm implements, $26,559; buildings, $1,035,589; library, $84,638; apparatus, $151,900; live stock, $16,276; miscellaneous, $66,675; total, $1,481,637.

Owing to the complicated organization of many of these institutions and the fact that the students in agricultural courses are in many subjects in classes with students in other courses, and that much of the equipment is used in common by the students in all the courses, it is impracticable to show by statistics, with exactness, the means and facilities for strictly agricultural education.

The reports received from the colleges during the past two years indicate that while the facilities for instruction in agricultural courses have been increased as the result of the act of Congress of 1890, the number of students in the regular college courses in agriculture still continues to be relatively small in many institutions. On the other hand, the short courses are increasingly popular, and wherever special courses, as in dairying, have been established they have been well attended. The success of the schools of agriculture having a curriculum of lower grade than that of the college, in Minnesota, Rhode Island, and Connecticut, is evidence that there is a demand for institutions which will receive students directly from the common schools and give them training in agricultural subjects along with those ordinarily taught in high schools. Experience in agricultural education in this country during the past thirty years shows that colleges of agriculture are mainly for those who have the means and the leisure to gain that liberal education which will fit them to be investigators, teachers, journalists, and managers of large agricultural enterprises. In a word, the colleges are principally useful in training the leaders in agricultural progress. This is a high duty, and its successful performance should entitle an institution to the gratitude and support of the people. But there is need that the masses of our agricultural population should have more ample opportunities for education in agricultural lines.

The experiment stations, through their bulletins and reports, are doing much to educate the adult farmer. The colleges also are doing more each year in what may be called university extension work through farmers' institutes. As the demand for instruction in agriculture increases, the colleges will undoubtedly shape their courses to meet the needs of the farmers as far as this is practicable. We shall then have experiment stations, college courses in agriculture, schools of agriculture, special schools in dairying, animal production, etc., farmers' institutes, and home readings as the complete system of education for the farmer, carried on under the auspices of the university or college.

This system, however, can not accomplish the most good for the greatest number of our agricultural population until the courses of

study in the common and high schools of the rural communities are so modified as to give the farmers' children that elementary training which will enable them to appreciate and apply what the experiment station and the college teach.

The countries of Europe are giving much attention to the elementary instruction of farmers' children in agricultural subjects. Teachers are being trained in normal schools, text-books are being prepared, and educational helps of various kinds are being devised in France, Belgium, and elsewhere, with a view to the needs of the masses of the rural population. There are difficult pedagogical problems to be solved in making such instruction thoroughly useful, and the movement must still be regarded as in an experimental stage. But the governments of these countries seem to be thoroughly in earnest and awake to the importance of bringing instruction in improved methods of agriculture home to the masses of the farmers. What the European governments are doing the people themselves in their local communities might undertake in this country. By providing that the children in the common schools should learn how to see, to use their hands, and to adapt means to useful ends, and that the farm boy or girl in the rural high school should be taught in outline the theory and practice of agriculture, an improvement might be made in our public school system which would soon show substantial results in more contented and prosperous rural communities.

STATISTICS OF AGRICULTURAL SCHOOLS, COLLEGES, AND EXPERIMENT STATIONS.

List of schools and colleges in the United States having courses in agriculture.

State.	Name of institution.	Locality.	President.
Alabama	Agricultural and Mechanical College of Alabama.	Auburn	W. L. Broun.
	State Normal and Industrial School.	Normal	W. H. Councill.
Arizona	University of Arizona	Tucson	T. B. Comstock.
Arkansas	Arkansas Industrial University	Fayetteville	E. H. Murfee.
	Branch Normal School	Pine Bluff	J. C. Corbin.
California	College of Agriculture of the University of California.	Berkeley	M. Kellogg.
Colorado	The State Agricultural College of Colorado.	Fort Collins	Alston Ellis.
Connecticut	Storrs Agricultural College	Mansfield	B. F. Koons.
	Sheffield Scientific School of Yale University.	New Haven	Timothy Dwight.
Delaware	Delaware College	Newark	A. N. Raub.
	State College for Colored Students	Dover	Wesley Webb.
Florida	Florida State Agricultural and Mechanical College.	Lake City	O. Clute.
	Florida State Normal School	Tallahassee	T. De S. Tucker.
Georgia	Georgia State College of Agriculture and Mechanic Arts.	Athens	H. C. White.
	Georgia Industrial College for Colored Youths.	College	R. R. Wright.
Idaho	College of Agriculture of the University of Idaho.	Moscow	F. B. Gault.
Illinois	College of Agriculture of the University of Illinois.	Urbana	T. J. Burrill.
Indiana	School of Agriculture, Horticulture, and Veterinary Science of Purdue University.	Lafayette	J. H. Smart.
Iowa	Iowa State College of Agriculture and Mechanic Arts.	Ames	W. M. Beardshear.
Kansas	Kansas State Agricultural College	Manhattan	Geo. T. Fairchild.
Kentucky	Agricultural and Mechanical College of Kentucky.	Lexington	J. K. Patterson.
	State Normal School	Frankfort	J. H. Jackson.
Louisiana	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge	J. W. Nicholson.

List of schools and colleges in the United States having courses in agriculture—Cont'd.

State.	Name of institution.	Locality.	President.
Louisiana	Southern University and Agricultural and Mechanical College.	New Orleans	H. A. Hill.
Maine	The Maine State College	Orono	A. W. Harris.
Maryland	Maryland Agricultural College	College Park	R. W. Silvester.
Massachusetts	Massachusetts Agricultural College	Amherst	H. H. Goodell.
Michigan	Michigan Agricultural College	Agricultural College.	L. G. Gorton.
Minnesota	College of Agriculture of the University of Minnesota.	Minneapolis	Cyrus Northrop.
	School of Agriculture of the University of Minnesota.	St. Anthony Park	H. W. Brewster.
Mississippi	Mississippi Agricultural and Mechanical College.	Agricultural College.	S. D. Lee.
	Alcorn Agricultural and Mechanical College.	Westside	
Missouri	College of Agriculture and Mechanic Arts of the University of Missouri.	Columbia	Richard H. Jesse.
	Lincoln Institute	Jefferson City	Inman E. Page.
Montana	Montana College of Agriculture and Mechanic Arts.	Bozeman	A. N. Ryon.
Nebraska	Industrial College of the University of Nebraska.	Lincoln	J. H. Canfield.
Nevada	School of Agriculture of the Nevada State University.	Reno	S. A. Jones.
New Hampshire	New Hampshire College of Agriculture and the Mechanic Arts.	Durham	C. S. Murkland.
New Jersey	Rutgers Scientific School	New Brunswick	Austin Scott.
New Mexico	New Mexico College of Agriculture and Mechanic Arts.	Las Cruces	Hiram Hadley.
New York	College of Agriculture of Cornell University.	Ithaca	J. G. Schurman.
North Carolina	The North Carolina College of Agriculture and Mechanic Arts.	Raleigh	A. Q. Holladay.
	Agricultural and Mechanical College for the Colored Race.	Greensboro	J. O. Crosby.
North Dakota	North Dakota Agricultural College	Fargo	J. B. Power.
Ohio	Ohio State University	Columbus	W. H. Scott.
Oklahoma	Agricultural and Mechanical College of Oklahoma.	Stillwater	R. J. Barker.
Oregon	Oregon State Agricultural College	Corvallis	John M. Bloss.
Pennsylvania	Pennsylvania State College	State College	George W. Atherton.
Rhode Island	Rhode Island College of Agriculture and Mechanic Arts.	Kingston	J. H. Washburn.
	Department of Agriculture and Mechanic Arts of Brown University.	Providence	E. B. Andrews.
South Carolina	Clemson Agricultural College	Clemson College	E. B. Craighead.
	College of Agriculture and Mechanic's Institute of Claflin University.	Orangeburg	L. M. Dunton.
South Dakota	South Dakota Agricultural College	Brookings	L. McLouth.
Tennessee	State Agricultural and Mechanical College of the University of Tennessee.	Knoxville	C. W. Dabney, jr.
Texas	State Agricultural and Mechanical College of Texas.	College Station	L. S. Ross.
	Prairie View State Normal School	Prairie View	L. C. Anderson.
Utah	Agricultural College of Utah	Logan	J. W. Sanborn.
Vermont	University of Vermont and State Agricultural College.	Burlington	M. H. Buckham.
Virginia	Virginia Agricultural and Mechanical College.	Blacksburg	J. M. McBryde.
	Hampton Normal and Agricultural Institute.	Hampton	H. B. Frissell.
Washington	Washington Agricultural College and School of Science.	Pullman	E. A. Bryan.
West Virginia	West Virginia University	Morgantown	P. B. Reynolds.
	The West Virginia Colored Institute	Farm	J. E. Campbell.
Wisconsin	College of Agriculture of the University of Wisconsin.	Madison	C. K. Adams.
Wyoming	College of Agriculture of the University of Wyoming.	Laramie	A. A. Johnson.

Statistics of agricultural schools and colleges in the United States.

State.	Number in faculty.	Students in 1893.	Students in agricultural courses in 1893.	Graduates in agricultural courses in 1893.	Total number of graduates in agricultural courses.	Revenues for 1893.	Number and length of agricultural courses.	Number of volumes in library.	Number scholarships open to students in agriculture.	Number of alumni engaged in agricultural lines.	Tuition fees. Residents of State.	Tuition fees. Nonresidents.	Value of grounds and buildings.	Value of scientific apparatus.	Value of library.
Alabama (Auburn)	30	238	115	12	96	$50,023	4 years, 2 years and postgraduate.	8,377	0	404	0	0	$120,000	$30,000	$10,000
Alabama (Normal)	...	...	...	...	...	24,819	...	...	...	...	...	...	...	...	...
Arizona	6	41	0	0	0	22,700	4 years	700	0	0	0	0	75,000	16,500	1,800
Arkansas	32	543	26	0	0	48,580	4 years	6,000	...	...	0	10	...	...	10,000
California	55	774	114	2	30	324,086	...	53,650	10	30	0	0	1,630,900	190,000	135,000
Colorado	21	132	18	2	18	59,656	4 years	4,280	0	16	0	0	120,000	50,000	4,922
Connecticut (New Haven)	55	601	0	0	13	137,046	3 years	6,500	80	118	$150	$150	400,000	50,000	10,000
Connecticut (Storrs)	9	109	89	15	99	15,710	4 years and 2 years	1,500	0	...	25	(*a*)	85,000	1,500	...
Delaware (Newark)	12	80	6	1	1	21,489	4 years, 2 years and 13 weeks	6,007	...	0	0	60	80,000	30,000	5,000
Delaware (Dover)	3	16	...	0	0	4,660	4 years	261	0	0	0	10	14,000	1,300	500
Florida (Lake City)	15	141	61	2	2	18,511	4 years	4,000	0	1	0	20	43,600	9,875	3,000
Florida (Tallahassee)	9	68	68	0	0	12,900	1 (undetermined)	504	0	0	0	...	8,105	2,000	500
Georgia (Athens)	15	95	78	7	265	29,254	4 years, 3 years, (2) postgraduate, and 3 months.	26,200	6	300	0	0	50,000	60,000	20,000
Georgia (College)	...	...	...	...	...	14,645	...	...	...	...	...	...	...	...	...
Idaho	6	230	3	0	0	34,514	4 years, 2 years, and 1 year	2,000	0	0	0	0	110,000	5,000	3,000
Illinois	24	732	33	2	42	140,048	4 years, 2 years, and 1 year	23,612	...	60	23	23	320,000	150,000	60,000
Indiana	51	603	80	4	17	84,430	4 years, 8 weeks	5,860	...	30	0	0	474,355	107,330	8,650
Iowa	42	...	...	3	238	138,988	4 years, 2 years, and 10 weeks.	10,853	0	119	0	0	353,100	54,261	17,000
Kansas	29	434	(*b*)	39	337	59,258	4 years	17,254	0	165	0	0	184,685	33,500	22,300
Kentucky (Lexington)	25	280	3	0	0	61,668	4 years, 2 years, and 4 months (*c*).	2,284	0	4	15	15	304,000	37,848	6,000
Kentucky (Frankfort)	6	75	28	5	13	6,413	2 years	218	...	...	...	...	8,000	1,695	300
Louisiana (Baton Rouge)	20	...	...	...	...	47,520	...	...	...	...	...	...	...	...	...
Louisiana (New Orleans)	10	623	42	1	1	31,315	4 years, 2 years	631	0	4	0	0	37,583	2,640	1,000
Maine	18	...	10	2	39	36,956	4 years, 2 years, 1 year, 4 months.	8,000	0	60	0	0	206,000	45,000	12,000
Maryland	15	144	86	5	...	31,342	4 years	550	26	...	140	140	68,600	10,000	1,100
Massachusetts	18	213	213	21	381	55,280	4 years, 2 years	14,500	320	191	0	80	242,265	18,641	20,000
Michigan	31	230	129	37	609	90,000	4 years	16,283	0	...	0	15	331,691	26,200	28,000
Minnesota (Minneapolis)	9	1,650	7	...	3	45,435	4 years	30,000	0	55	5	5	96,150	...	40,000
Minnesota (St. Anthony Park)	21	...	167	21	62	...	3 years, 4 weeks (dairy course).	...	...	...	0	0	...	...	...
Mississippi (Agricultural College).	23	230	156	17	153	46,056	4 years	3,456	...	32	0	20	182,051	14,483	3,802

Mississippi (Westside)	11					29,412									
Missouri (Columbia)	18	457	343		(d)	61,765	4 years	14,000	0	(d)	0	0	237,255	40,385	15,000
Missouri (Jefferson City)	10					977	4 years								
Montana	8	95	12	0	0	33,050	4 years		0	0	10	10	8,000		
Nebraska	42	1,200	25	0	8	60,902	6 years, 2 years, 1 year, and 2 weeks.			41					
Nevada	15	167	9	0	2	38,000	4 years	3,468	0	0	0	0	77,562	11,864	7,320
New Hampshire	15	61	(b)	1	30	110,503	4 years, 4 weeks	3,000	73	40	60	60	188,000	5,000	
New Jersey	30					37,411		29,466	290		75	75			
New Mexico	11	109	9	0	0	25,007	4 years	1,856	0	0	(f)		37,916	23,319	3,775
New York	14	1,712	105	5	41	504,463	4 years, 2 years, 11 weeks	150,000	548	500	0	0	1,564,941	515,135	325,471
North Carolina (Raleigh)	19	190	19	5	5	23,619	4 years	1,500	120	3	20	20	70,000		1,000
North Carolina (Greensboro)		53				13,813	3 years	200	96		(g)		31,000		
North Dakota	14	59	59	0	0	20,421	4 years	1,326	0	0	0	0	60,000	6,200	3,000
Ohio	50	750	62	1	11	266,849	4 years, 2 years	11,936	176		15	15	1,390,000	75,000	25,000
Oklahoma	9	95	94	0	0	28,480	4 years	440	0	0	10	20	13,750	5,399	3,552
Oregon	18	237	33	8	14	31,389	3 years	1,950	122		5	15	121,012	5,000	6,000
Pennsylvania	40	316	35	0	57	154,282	4 years, lecture course and dairy courses.	9,000	50		0	100	600,000	75,000	25,000
Rhode Island (Providence)	56	592	5	8	200		4 years	80,000	51	100	150	150	1,250,000	27,100	500,000
Rhode Island (Kingston)	14	80	60	0	0	24,000	4 years	1,000				25	94,000	8,000	3,000
South Carolina (Clemson College).	16	444	87	0	0	93,726	4 years	1,000	0		(e)		300,000	25,000	1,000
South Carolina (Orangeburg)	13	300	23	3	5	55,744	3 years	1,600	0	3	17	17	53,000	2,000	1,600
South Dakota	24	135	26	2	42	27,721	4 years	7,000		21	9	15	120,000	3,500	4,000
Tennessee	21	288	35	0		55,131	4 years	9,884			0	50	575,000	18,807	10,000
Texas (College Station)	29	273	152	7	49	51,155	4 years			12	10	10	350,000	100,000	
Texas (Prairie View)	11					28,134									
Utah	20	225	14	3		76,963	4 years, 2 years, 10 weeks	3,000	0	0	5	5	160,000	30,000	3,000
Vermont	17	246	66	2	3	65,521	4 years, 2 years, 1 year, dairy course.	45,461		100	60	60	250,000	25,000	70,000
Virginia (Blacksburg)	21	228	50	2	87	41,081	4 years	2,500	200		30	30	120,850	40,000	2,500
Virginia (Hampton)	43	618	122			46,967	3 years	6,310			0	0	560,000	1,000	4,000
Washington	11	86	8	1	1	130,000	4 years	664			0		56,000	1,613	
West Virginia (Morgantown)	17					73,170									
West Virginia (Farm)	5	45				4,675	3 years	478	0				18,000		500
Wisconsin	20	175	175	19	42	66,452	4 years, short course, dairy course.	4,000	40	410	0	6	110,000	15,000	6,000
Wyoming	10	105	0	0	0	30,000	4 years, 2 years, 1 year	2,650	0				100,000	20,000	4,000
Total	1,282	17,623	3,160	265	3,016	4,024,132		647,219	2,208	2,819			14,061,671	2,027,095	1,448,592

a Nonresidents not received.
b All enter the same course the first year.
c All students (male) required to attend the four months' course.
d Records destroyed by fire.
e Free to students whose parents are not worth over $5,000, to others $40. Nonresidents not admitted.
f Residents of United States $3 per year, nonresidents $50.
g One dollar per month.

Revenue of the agricultural schools and colleges in the United States receiving aid from the General Government.

States.	Revenue for 1893 from— United States. Land grant of 1862.	Endowment of 1890.	State.	Local communities.	Individuals.	Fees.	Farm produce.	Miscellaneous.	Total.
Alabama (Auburn)	$20,280	$10,118	$16,834			$1,451	$1,011	$329	$50,023
Alabama (Normal)		7,882						16,937	24,819
Arizona		18,000	4,500			200			22,700
Arkansas	10,400	13,091	23,575			1,514			48,580
California	21,094	18,000	115,575					169,417	324,086
Colorado	10,244	18,000	29,519				1,893		59,656
Connecticut (New Haven)	4,468	18,000			$30,000	67,156		17,422	137,046
Connecticut (Storrs)			15,000			710			15,710
Delaware (Newark)	4,980	14,400				2,109			21,489
Delaware (Dover)		3,600	1,000				60		4,660
Florida (Lake City)		9,000	9,107			404			18,511
Florida (Tallahassee)		9,000	3,900						12,900
Georgia (Athens)	16,954	12,000					300		29,254
Georgia (College)		6,000						8,645	14,645
Idaho		18,000						16,514	34,514
Illinois	26,082	18,000	63,533			16,570		15,863	140,048
Indiana	17,000	18,000	30,000			15,952	1,487	2,000	84,439
Iowa	43,929	18,000	31,164	$3		3,956	31,341	10,595	138,988
Kansas	30,187	18,000	2,706				4,782	3,583	59,258
Kentucky (Lexington)	9,900	15,390	31,749			4,187		442	61,668
Kentucky (Frankfort)		2,610	3,742			61			6,413
Louisiana (Baton Rouge)	9,115	8,727						29,678	47,520
Louisiana (New Orleans)	8,566	9,930	10,000				664	2,155	31,315
Maine	6,275	18,000	5,000				2,534	5,147	36,956
Maryland	6,142	18,000	12,142			11,462	1,890	1,706	51,342
Massachusetts	7,334	12,000	24,125		664		4,814	6,343	55,280
Michigan	36,000	18,000						36,000	90,000
Minnesota (Minneapolis)	14,977	18,000	9,128			778	1,630	922	45,435
Mississippi (Agricultural College)	5,915	8,075	24,835			675	6,556		46,056
Mississippi (Westside)	5,679	9,930						13,803	29,412
Missouri (Columbia)	15,850	17,023	25,000			350	3,542		61,765
Missouri (Jefferson City)		977							977
Montana		18,000	15,000			50			33,050
Nebraska	42,652	18,000						250	60,902
Nevada		18,000	20,000						38,000
New Hampshire	4,800	18,000	63,500			687	2,043	21,473	110,503
New Jersey	6,960	18,000				12,481			37,441
New Mexico		18,000	6,100			907			25,007
New York	18,000	18,000			25,000	104,449	4,834	334,180	504,463

North Carolina (Raleigh)	3,750	11,689	5,000			2,086	694	400	23,619
North Carolina (Greensboro)		6,311	7,500						13,811
North Dakota		18,000					2,421		20,421
Ohio	29,849	18,000	86,864			21,128	4,858	106,150	266,849
Oklahoma		18,000		10,000			480		28,480
Oregon	10,952	18,000					659	1,778	31,389
Pennsylvania	30,510	18,000	97,772			7,000	1,000		154,282
Rhode Island (Kingston)			20,000			4,000			24,000
South Carolina (Clemson College)	5,754	33,000	50,000		3,242	1,000	480	250	93,726
South Carolina (Orangeburg)	5,744	33,000	3,000			2,500	2,000	9,500	55,744
South Dakota		18,000	5,000				4,721		27,721
Tennessee	23,760	18,000						13,371	55,131
Texas (College Station)	14,280	13,500	20,000			3,375			51,155
Texas (Prairie View)		4,500						23,634	28,134
Utah		18,000	54,000			1,765	2,176	1,022	76,963
Vermont	8,130	18,000	6,000			7,412	4,049	21,930	65,521
Virginia (Blacksburg)	20,659	12,000	2,500			4,391		1,531	41,081
Virginia (Hampton)	10,329	6,000					23,406	7,232	46,967
Washington		33,000	97,000						130,000
West Virginia (Morgantown)		15,000						58,170	73,170
West Virginia (Farm)		3,000	1,000			375	300		4,675
Wisconsin	16,962	18,000	29,500		2,000				66,462
Wyoming		18,000	12,000						30,000
Total	584,462	898,753	1,093,870	10,003	60,996	301,141	116,625	958,372	4,024,132

Additions to equipment of agricultural schools and colleges in the United States receiving aid from the General Government.

State.	Value of additions to equipment in 1893.						
	Farm implements.	Buildings.	Library.	Apparatus.	Live stock.	Miscellaneous.	Total.
Alabama (Auburn)	$420	$7,911	$3,276	$6,986		$108	$18,701
Alabama (Normal)							
Arizona	500	6,500	350	3,100		250	10,700
Arkansas	142				$105	487	734
California	600	47,600	6,000	10,000			64,200
Colorado	1,500	3,500	500	4,300	700	747	11,247
Connecticut (New Haven)		88,267	552	611		308	89,738
Connecticut (Storrs)			300	300			600
Delaware (Newark)	2,715	3,635	1,338	4,554		396	12,638
Delaware (Dover)	125				100		225
Florida (Lake City)			243	18			261
Florida (Tallahassee)	2,039	6,618	63	917			9,637
Georgia (Athens)	300		1,005	1,021			2,326
Georgia (College)							
Idaho							
Illinois		172,500	2,000	9,992			184,492
Indiana	165	78,000		6,000			84,165
Iowa	89		2,000	5,694		800	8,583
Kansas			2,242	5,265	400	6,288	14,195
Kentucky (Lexington)		3,514	498	2,848		2,144	9,004
Kentucky (Frankfort)							
Louisiana (Baton Rouge)							
Louisiana (New Orleans)	125	3,431	12	1,305	300	175	5,348
Maine			903	3,224			4,127
Maryland	500	5,500	100	450	600		7,150
Massachusetts	876		2,944		1,543		5,363
Michigan							
Minnesota (Minneapolis)	278		741	647	234		1,900
Mississippi (Agricultural College)		1,331		5,847			7,178
Mississippi (Westside)							
Missouri (Columbia)	200	25,000	500	1,000	400	600	27,700
Missouri (Jefferson City)							
Montana							
Nebraska	200	750	2,500	4,000			7,450
Nevada		500	843	2,516		1,332	5,191
New Hampshire	1,081	109,778	1,534	12,387			124,780
New Jersey			29	554		222	805
New Mexico	116	1,872	774	1,513		402	4,677
New York	500	122,948	42,400		200	40,911	206,959
North Carolina (Raleigh)	225	5,432	100	2,539			8,296
North Carolina (Greensboro)	550	200			300		1,050
North Dakota	1,098		427	1,485	440		3,450
Ohio	1,595	121,283			3,460		126,338
Oklahoma	195	750	195	88		355	1,583
Oregon	92				150	250	492
Pennsylvania		150,000	500	10,000	2,000		162,500
Rhode Island (Kingston)	100	1,000	300	2,000	500	500	4,400
South Carolina (Clemson College)	2,000	15,000	1,000	15,000	2,500	5,000	40,500
South Carolina (Orangeburg)	3,000	3,000	4		835		6,839
South Dakota	14		509	507			1,030
Tennessee	108	14,200	1,650	2,975	220	2,456	21,609
Texas (College Station)							
Texas (Prairie View)							
Utah	100	75,000	200	9,470	300	1,000	86,070
Vermont	1,146	1,051	2,911	1,327	350		6,785
Virginia (Blacksburg)		5,000		2,000		1,000	8,000
Virginia (Hampton)	790			1,120			1,910
Washington	2,651	42,518	1,834	5,956	639		53,598
West Virginia (Morgantown)							
West Virginia (Farm)	160		93			125	378
Wisconsin	165		315	1,475		75	2,030
Wyoming	99	12,000	953	909		744	14,705
Total	26,559	1,135,589	84,638	151,900	16,276	66,675	1,481,637

The locations, directors, and principal lines of work of the agricultural experiment stations in the United States.

State.	Location.	Director.	Principal lines of work.
Alabama (College)	Auburn	W. L. Broun	Meteorology; analysis and control of fertilizers; botany; mycology; field experiments.
Alabama (Canebrake)	Uniontown	H. Benton	Field experiments.
Arizona	Tucson	F. A. Gulley	Field experiments with crops and fruits; irrigation.
Arkansas	Fayetteville	R. L. Bennett	Analyses of soils, fertilizers, and feeding stuffs; field experiments with crops and fruits; veterinary science.
California	Berkeley	E. W. Hilgard	Soils; composition and cultivation of field crops, grapes, and orchard fruits; diseases of plants and seeds; composition of feeding stuffs; entomology; technology; drainage and irrigation.
Colorado	Fort Collins	Alston Ellis	Systematic botany; meteorology; field experiments with crops; testing varieties of vegetables and fruits; entomology; irrigation.
Connecticut (State)	New Haven	S. W. Johnson	Methods of analysis; analysis and inspection of fertilizers; field experiments; analysis of feeding stuffs; chemistry of milk and its products; tests of forage plants.
Connecticut (Storrs)	Storrs	W. O. Atwater	Chemistry of foods and feeding stuffs; bacteriology of milk and its products; field experiments with crops.
Delaware	Newark	A. T. Neale	Chemistry; field experiments with crops; horticulture; diseases of plants and animals; dairying.
Florida	Lake City	O. Clute	Chemistry; field experiments with crops; horticulture.
Georgia	Experiment	R. J. Redding	Field experiments with fertilizers and crops; horticulture; dairying.
Idaho	Moscow	C. P. Fox	Field crops; fruits and vegetables; irrigation.
Illinois	Champaign	G. E. Morrow	Chemistry; field experiments with crops; horticulture; diseases of plants; feeding experiments and dairying.
Indiana	Lafayette	C. S. Plumb	Field experiments; horticulture; feeding experiments; diseases of plants and animals.
Iowa	Ames	James Wilson	Chemistry; field experiments; horticulture; diseases of plants; entomology; dairying.
Kansas	Manhattan	Geo. T. Fairchild	Field experiments; horticulture; diseases of plants and animals; feeding experiments; entomology.
Kentucky	Lexington	M. A. Scovell	Chemistry; analysis and inspection of fertilizers; field experiments; horticulture; diseases of plants; entomology; dairying.
Louisiana (Sugar)	New Orleans	W. C. Stubbs	Field experiments; horticulture; sugar-making; drainage; irrigation.
Louisiana (State)	Baton Rouge	W. C. Stubbs	Chemistry; field experiments; horticulture; diseases of plants and animals; entomology.
Louisiana (North)	Calhoun	W. C. Stubbs	Field experiments.
Maine	Orono	W. H. Jordan	Field experiments; horticulture; diseases of plants; digestibility of feeding stuffs; feeding experiments with milch cows and pigs; dairying.
Maryland	College Park	R. H. Miller	Chemistry; field experiments with fertilizers, crops, vegetables, and fruits.
Massachusetts (State)	Amherst	C. A. Goessmann	Chemistry; analysis and control of fertilizers; field experiments; diseases of plants; analysis of feeding stuffs; feeding experiments.
Massachusetts (Hatch)	Amherst	H. H. Goodell	Meteorology; field experiments with fertilizers and fruits; entomology.

The locations, directors, and principal lines of work of the agricultural experiment stations in the United States—Continued.

State.	Location.	Director.	Principal lines of work.
Michigan	Agricultural College.	L. G. Gorton	Field crops; vegetables and fruits; ensilage; feeding animals.
Minnesota	St. Anthony Park	W. M. Liggett	Chemistry; field experiments with vegetables and fruits; entomology; dairying.
Mississippi	Agricultural College.	S. M. Tracy	Botany; field experiments; feeding experiments; veterinary science; entomology; dairying.
Missouri	Columbia	E. D. Porter	Chemistry; field crops; vegetables and fruits; feeding experiments; veterinary science and practice.
Montana	Bozeman	S. M. Emery	
Nebraska	Lincoln	C. L. Ingersoll	Chemistry; meteorology; soils; field experiments; entomology.
Nevada	Reno	S. A. Jones	Soils; field crops; horticulture; diseases of plants; entomology; dairying.
New Hampshire	Durham	G. H. Whitcher	Chemistry; field experiments; feeding experiments; dairying.
New Jersey (State)	New Brunswick	E. B. Voorhees	Chemistry; analysis and control of fertilizers; field experiments.
New Jersey (College)	New Brunswick	Austin Scott	Botany; diseases of plants; weeds; feeding experiments with milch cows; entomology.
New Mexico	Las Cruces	H. Hadley	Field crops; vegetables and fruits; entomology.
New York (State)	Geneva	Peter Collier	Chemistry; meteorology; analysis and control of fertilizers; field experiments with fertilizers, crops, vegetables, and fruits; diseases of plants; feeding stuffs; dairying.
New York (Cornell)	Ithaca	I. P. Roberts	Field crops; field and greenhouse experiments with vegetables and fruits; feeding experiments; entomology; dairying.
North Carolina	Raleigh	H. B. Battle	Chemistry; meteorology; analysis and control of fertilizers; field experiments with fertilizers; crops, vegetables, and fruits; seed testing; analysis of feeding stuffs.
North Dakota	Fargo	J. B. Power	Botany; field experiments; forestry; diseases of plants.
Ohio	Wooster	C. E. Thorne	Field experiments with fertilzers, crops, vegetables, and fruits; entomology.
Oklahoma	Stillwater	J. C. Neal	Field experiments with crops, vegetables, and fruits.
Oregon	Corvallis	J. M. Bloss	Soils; field experiments; and entomology.
Pennsylvania	State College	H. P. Armsby	Chemistry; analysis of fertilizers; field experiments; composition of feeding stuffs; feeding experiments; dairying.
Rhode Island	Kingston	C. O. Flagg	Chemistry; analysis and control of fertilizers; field experiments; veterinary science and practice; agriculture.
South Carolina	Clemson College	E. B. Craighead	Analysis and control of fertilizers; field experiments.
South Dakota	Brookings	L. McLouth	Meteorology; field experiments; forestry; entomology; dairying.
Tennessee	Knoxville	C. F. Vanderford	Botany; soils; field experiments; feeding experiments.
Texas	College Station	J. H. Connell	Field experiments; diseases of plants; feeding experiments; veterinary science and practice; dairying.
Utah	Logan	J. W. Sanborn	Field experiments; feeding experiments; irrigation.
Vermont	Burlington	J. L. Hills	Chemistry; analysis and control of fertilizers; field experiments; diseases of plants; feeding experiments; entomology; dairying.
Virginia	Blacksburg	J. M. McBryde	Field experiments; veterinary science and practice
Washington	Pullman	E. A. Bryan	Field experiments; forestry.

The locations, directors, and principal lines of work of the agricultural experiment stations in the United States—Continued.

State.	Location.	Director.	Principal lines of work.
West Virginia	Morgantown	J. A. Myers	Analysis and control of fertilizers; chemistry; botany; field experiments; entomology.
Wisconsin	Madison	W. A. Henry	Chemistry; soils; field experiments; feeding experiments; dairying.
Wyoming	Laramie	A. A. Johnson	Botany; soils; field and feeding experiments; entomology; irrigation.

Revenue of the agricultural experiment stations in 1893.

Stations.	Revenue for 1893 from—						Total.
	United States.	States.	Individuals.	Fees.	Farm products.	Miscellaneous.	
Alabama (College)	$15,000	$8,417			$1,011	$450	$24,878
Alabama (Canebrake)		2,500			800	69	3,369
Arizona	15,000				129	112	15,241
Arkansas	15,000						15,000
California	15,000	18,810					33,810
Colorado	15,000				1,340	737	17,077
Connecticut (State)	7,500	8,000		$6,130		41	21,671
Connecticut (Storrs)	7,500				500		8,000
Delaware	15,000				95		15,095
Florida	15,000						15,000
Georgia	15,000	5,000			2,000		22,000
Idaho	15,000				15	50	15,065
Illinois	15,000			70			15,070
Indiana	15,000				1,532		16,532
Iowa	15,000	1,500					16,500
Kansas	15,000						15,000
Kentucky	15,000			3,165	604	402	19,171
Louisiana	15,000	4,000	$4,100	2,000	1,500		26,600
Maine	15,000				326		15,326
Maryland	15,000				488		15,488
Massachusetts (State)		10,000		2,500	1,000		13,500
Massachusetts (Hatch)	15,000				516	88	15,604
Michigan	15,000			1,000	1,037		17,037
Minnesota	15,000						15,000
Mississippi	15,000				399	944	16,343
Missouri	15,000				1,152		16,152
Montana							
Nebraska	15,000						15,000
Nevada	15,000				118		15,118
New Hampshire	15,000				2,000		17,000
New Jersey (State)		11,000					11,000
New Jersey (College)	15,000						15,000
New Mexico	15,000				115		15,115
New York (State)		68,500					68,500
New York (Cornell)	15,000					585	15,585
North Carolina	15,000	8,000			400		23,400
North Dakota	15,000					564	15,564
Ohio	15,000	9,716			4,028	192	28,936
Oklahoma	15,000						15,000
Oregon	15,000						15,000
Pennsylvania	15,000			7,172	2,702		24,874
Rhode Island	15,000			1,521	951	56	27,528
South Carolina	15,000				480		15,480
South Dakota	15,000						15,000
Tennessee	15,000				2,818		17,818
Texas	15,000						15,000
Utah	15,000				2,246		17,246
Vermont	15,000				3,832		18,832
Virginia	15,000				3,750		18,750
Washington	15,000						15,000
West Virginia	15,000			4,063	310	152	19,525
Wisconsin	15,000	9,542			5,438		29,980
Wyoming	15,000				293		15,293
Total	705,000	164,985	4,100	27,621	43,925	4,442	950,073

Additions to the equipment of agricultural experiment stations in 1893.

Stations.	Value of additions to equipment in 1893.						
	Farm implements.	Building.	Library.	Apparatus.	Live stock.	Miscellaneous.	Total.
Alabama (College)	$420	$2,696	$500	$2,004	....	....	$5,620
Alabama (Canebrake)	105	....	36	50	$125	$50	366
Arizona	65	8	....	192	....	29	294
Arkansas	50	720	43	50	180	141	1,184
California	564	733	254	328	....	....	1,879
Colorado	82	624	31	214	200	54	1,205
Connecticut (State)	....	....	365	....	....	125	490
Connecticut (Storrs)	....	....	....	959	....	57	1,016
Delaware	116	75	533	354	120	396	1,594
Florida	179	455	62	....	....	....	696
Georgia	300	3,000	20	....	300	100	3,720
Idaho	951	3,000	225	1,155	396	....	5,727
Illinois	75	....	650	150	....	....	875
Indiana	78	500	149	288	315	....	1,330
Iowa	100	50	50	200	....	....	400
Kansas	....	....	200	630	....	....	830
Kentucky	146	708	557	426	250	1,099	3,186
Louisiana	100	....	250	1,000	....	1,000	2,350
Maine	....	....	150	....	....	....	150
Maryland	580	574	160	....	265	....	1,579
Massachusetts (State)	....	....	200	500	....	100	800
Massachusetts (Hatch)	....	750	....	....	....	....	750
Michigan	75	2,744	501	49	445	....	3,814
Minnesota	....	....	....	....	....	....	....
Mississippi	125	1,200	127	250	....	500	2,202
Missouri	423	....	33	....	328	....	784
Montana	....	....	....	....	....	....	....
Nebraska	....	....	....	....	....	....	....
Nevada	....	751	63	466	....	....	1,280
New Hampshire	500	13,000	2,000	500	500	....	16,500
New Jersey (State)	....	....	....	....	....	....	....
New Jersey (College)	....	746	939	387	....	....	2,072
New Mexico	93	750	....	1,507	....	499	2,849
New York (State)	75	5,000	100	500	350	50	6,075
New York (Cornell)	....	....	25	150	75	250	500
North Carolina	....	400	175	200	....	100	875
North Dakota	....	688	173	255	....	....	1,116
Ohio	1,079	14,589	81	153	1,090	8,093	25,085
Oklahoma	511	750	93	1,714	421	....	3,489
Oregon	....	....	....	....	....	....	....
Pennsylvania	....	....	....	....	....	....	....
Rhode Island	487	458	1,318	273	168	151	2,855
South Carolina	....	....	224	34	....	43	301
South Dakota	....	....	....	....	....	....	....
Tennessee	50	....	184	349	181	188	952
Texas	9	375	250	149	....	37	820
Utah	50	750	75	....	175	....	1,050
Vermont	258	617	....	442	221	....	1,538
Virginia	500	300	....	500	750	250	2,300
Washington	....	....	....	....	....	....	....
West Virginia	89	1,292	222	423	5	15,866	17,897
Wisconsin	100	825	180	730	225	165	2,225
Wyoming	45	450	18	141	....	584	1,238
Total	8,380	59,578	11,216	17,672	7,085	29,927	133,858

Table showing the total number of members in the working staffs of experiment stations in the United States and the number of such officers pursuing different specialties.

NOTE.—A capital letter signifies that one of the number which it follows represents an officer who, having two titles and belonging by his first title in the column for which the letter stands, has already been entered there. Thus the entry 1 H under entomologists and opposite Arizona means that one officer is known as botanist and entomologist, and has already been entered by his first title in the H, or botanists', column. Two letters indicate that two of the preceding number have been entered elsewhere.

Stations.	Number in staff.	A Directors.	B Secretaries and treasurers.	C Librarians.	D Clerks.	E In charge of sub-stations.	F Agriculturists.	G Biologists.	H Botanists.	I Chemists.	K Entomologists.	L Geologists.	M Horticulturists.	N Irrigation engineers.	O Meteorologists.	P Mycologists and bacteriologists.	Q Physicists.	R Veterinarians.	S Dairymen.	T Farm foremen.	U Miscellaneous.
Alabama (College)	9	1			1		1	1 F	2 D	4					1 H			1			
Alabama (Canebrake)	4	2	1															1			
Arizona	9	1				1			1	2	1 H		1	1	1 I						*a* 1
Arkansas	7	1		1		2	1 A			2 C			1					1			
California	24	1			1	12	2		1	3 A	1	2 AI	1								*b* 3
Colorado	18	1	2		1	3	2	1	1	2	2 G		2 H	2	2 N						
Connecticut (State)	12	2		1	1 C					6 A						1					*c* 3
Connecticut (Storrs)	4	2					1			1 A											*d* 1
Delaware	5	1								1	1 M		1		1	1					
Florida	8	1			1	2	1	1		1			1								
Georgia	5	2					1			1 A			1						1		
Idaho	9	1				3			1	1	1				1						*e* 1
Illinois	10	1	1				2 A		2 M	2	1		2					1			
Indiana	9	1					2		2	2			1					1			
Iowa	12	2					1		2	1	2		2					2			
Kansas	13	1	1				3	1	2	2	2 M		2					1 G			*f* 1 M
Kentucky	10	1			1				2 KK	2	2		2					1		1	
Louisiana (Sugar)	9	2	1							3										1	*g* 2
Louisiana (State)	9	2							1	2	1		2 K					1		1	
Louisiana (North)	5	2								1										1	*h* 1
Maine	12	1		1			1		2	2	2 HH		2		1					1	
Maryland	7	1	1				2 A	1 K		1	1		1				1				
Massachusetts (State)	11	1			1 I					10 A										1	*i* 3 III
Massachusetts (Hatch)	12	1	1				2				3		3		1						*k* 1
Michigan	15	1	1	1	1		2	1	1	3			3					1			
Minnesota	10	2	1				1 A		1 K	1	1		1					2	1	1	

a Engineer.
b Inspector of stations, foreman of grounds, and foreman of cellar.
c Grass agent, foreman in charge of buildings and grounds, and laboratory assistant.
d Assistant in farm experiments.
e Civil engineer.
f Foreman of garden.
g Machinist, sugar-maker.
h In charge of stock.
i Assistant in field experiments and stock-feeding.
k Auditor.

Table showing the total number of members in the working staffs of experiment stations in the United States, etc.—Continued.

Stations.	Number in staff.	A Directors.	B Secretaries and treasurers.	C Librarians.	D Clerks.	E In charge of substations.	F Agriculturists.	G Biologists.	H Botanists.	I Chemists.	K Entomologists.	L Geologists.	M Horticulturists.	N Irrigation engineers.	O Meteorologists.	P Micologists and bacteriologists.	Q Physicists.	R Veterinarians.	S Dairymen.	T Farm foremen.	U Miscellaneous.
Mississippi	12	1	1			4	1			2	1		1					1			
Missouri	7	1	2				2 A			1			1							1	
Montana	5	1			1		1			1			1 A					1			
Nebraska	12	1			1		2 A		1	2	1	1	1				1	1		1	
Nevada	6	1		1			1		1 K	1	1		1 F							1	
New Hampshire	10	1								3	1				1	1			1	1	*a* 1
New Jersey (State)	6	1			2					3 A											*b* 1
New Jersey (College)	9	1		1 D	4			1	1		1		1 H							1	
New Mexico	8	1			1		2 MM	1 K		3	1		2								
New York (State)	13	2			1			1		7			2								
New York (Cornell)	14	2	2 A				2 A		2	2	2		2					1		1	
North Carolina	12	1	1				1		1	5 A	H		2		2						
North Dakota	8	1	1				1		1	1								1		1	*c* 1
Ohio	8	2	1			1	1			1	1		2 A								
Oklahoma	7	1					1		1 A	1	2 A H		1							1	*d* 1
Oregon	6	1					1		1	1	1		1								
Pennsylvania	15	2	1				2		1	6 A			1							1	*e* 2
Rhode Island	8	1		1			2 A			2			1							1	*f* 1
South Carolina	11	1			1		2			4			1						1	1	
South Dakota	15	1	1	1	1		1		1	2	1 H		2		1			2	1	1	
Tennessee	8	1		1 D	1		1 A		2	2			1							1	
Texas	10	2			1		2			3 O			1		1			1			
Utah	9	1	1		1			1		1	1 M		1	1				1		1	
Vermont	10	1	1		1				1	2 A	1		1					1	1	1	
Virginia	8	2	1				1	1		2	1 A M		1 A			*g* 1		1			
Washington	6	1					1		1	1	1 H		2 F							1	
West Virginia	8	1	1		1		1			1	2		1								*h* 1 M
Wisconsin	10	1			1					2			1			1	1	1	1	1	
Wyoming	13	1	1			5			1	1	1	1	1				1			1 K	
Total	532	70	25	8	27	33	54	11	37	119	42	4	62	4	13	5	4	26	7	25	25

a Laboratory assistant.
b Janitor and laboratory attendant.
c Arboriculturist.
d Mechanic.
e Gardener and assistant in field experiments.
f Apiarist and poultry manager.
g The vice-director is also horticulturist, entomologist, and mycologist.
h Microscopist.

REPORT OF THE STATISTICIAN.*

SIR: I have the honor to submit my first annual report as Statistician of this Department, it being the 30th annual report made by the head of the Division of Statistics. It is proper that I should express my sense of the great responsibility attached to the important position which you have intrusted to me. To merit the confidence thus bestowed will be the object of my earnest endeavor.

Very respectfully,

HENRY A. ROBINSON,
Statistician.

Hon. J. STERLING MORTON,
Secretary.

INTRODUCTORY.

The science of statistics presents a vast and ever extending field, the cultivation of which requires strenuous and persistent devotion and effort.

The agricultural branch of statistics, if regard be had for the basic importance of the agricultural art or industry, is the principal one of the group. As has been well said, "it is safe to assume that as the proportions of the value of agricultural interests are to all interests, so is the value of purely agricultural statistics to statistics in general." The farming population of this country comprises nearly one-half of the total population, and the products of the farm constitute the principal part of the commodities that enter into the channels of our commerce, both domestic and foreign. It is therefore very important, in the interests of the whole people, that agricultural data should be carefully and reliably collected, treated, and published. The system adopted by the Department of Agriculture for the collection of the data referred to, while it may not be the best conceivable, is, perhaps, when expense of gathering and other important elements are taken into consideration, the best that has hitherto been attainable. Suggestions will, however, be submitted in the near future looking to the attainment of more exact information on certain important points.

*NOTE.—Owing to the delay in providing for the printing of the Annual Report of the Department of Agriculture, the MS. therefor was not called for at the usual time, namely, the close of the calendar year, which the report is intended to cover. The report of the Statistician being among the last reports called for, the MS was not submitted until April, and that officer was therefore permitted to extend his report so as to cover in some cases certain facts relating to a distribution of crops, etc., up to and including March 1, 1894.

This Department has in its service for the collection of information two corps of correspondents, one of which reports directly to the Statistician. This corps, when full, numbers 10,000, and is composed of 4 members in each of 2,500 counties, these comprising all the counties in the United States, except a few hundred, which, on account of their urban character or their scanty population, have practically no agricultural crops. The other corps consists also of a board of 4 members in each of the counties of the different States of the Union who report to officers residing in their respective States, and entitled "State agents of the Department of Agriculture." It is the duty of these officers to consolidate the returns made to them and forward the results to the Statistician for his use in the preparation of all returns for publication. As a further means of approximating accuracy, resort is had in some cases to selected farmers not regular correspondents, of whom the Department has a list of over 150,000. It will thus be seen that great effort is made to secure trustworthy data, and the eagerness with which the Government reports are awaited by those especially interested bears strong practical testimony to the success attained.

It is appropriate in this connection to say that the demand for the various reports of the Division of Statistics is in excess of ability, under present circumstances, to supply. This demand is not confined to Senators, Representatives, editors, and publicists, but is general and popular. A very considerable part of the work of the office, however, arises from the special demands of the nation's lawmakers for statistical information, and much of the time of the experts in research in the employment of the Division of Statistics is devoted to the supply of this demand. The recent extraordinary session of Congress caused an unusual demand upon this division for statistical data pertinent to subjects of legislative discussion.

In addition to primary investigations at home, the range of endeavor in foreign fields has been and will be continued. The demands for the compilation of foreign statistics are on the increase. These include inquiries relating to acreage, production, and rate of yield of the principal and the minor crops; to the number and the produce of farm stock; to farm wages; to wholesale, retail, and farm prices; to quantities and values of exports and imports; to customs duties on agricultural products, and to a variety of other points of economic importance. To satisfy the demands for this information coming from foreign and domestic sources requires a large amount of painstaking labor, which is performed by a number of clerks who are experts in the compilation of foreign statistics. The records of foreign and domestic investigations have been increased. Numerous inquiries have been received during the past year regarding domestic crops other than corn, wheat, and oats. Reports in relation to rye, barley, buckwheat, potatoes, tobacco, cotton, and hay had been dropped since 1888. The data for these crops were collected but not published. In the December report the publication of the usual data in regard to at least five of these crops was resumed. Many inquiries are made regarding minor crops, and it is desirable that the means of extending our investigations in the direction indicated by these inquiries should be supplied. Every effort has been and will continue to be made to extend our work into new fields, with a view of ultimately obtaining all useful information as to the agricultural industry. The value of the minor crops aggregates millions of dollars and constitutes a very considerable part of the farmer's annual income, so that reliable and definite information in regard to them is desirable. They embrace the fruits, small and

great; rice, grasses, fibers; vegetables, such as beans and peas; the dairy and poultry products, etc. Of course, the inclusion of these subjects in our investigations and reports would necessarily involve increase of expense, for which provision should be made.

CROPS OF THE YEAR.

METEOROLOGY.

The meteorological records of the growing season, covering the period from April to September, inclusive, have been compiled from the Monthly Weather Review, published under the direction of the Chief of the Weather Bureau of the Department of Agriculture. The data presented in the subjoined tables show that there has been during the period of crop growth a deficiency of rainfall in the principal agricultural districts, except the North Pacific coast region, the Ohio Valley, and the Middle Atlantic States. In the Middle Atlantic States there was an excess of rainfall over the normal during the months of April, May, and September, which more than balanced the aggregate deficiency for July and August. In the Ohio Valley and Tennessee the records show a large excess during April and May, while the rainfall during the following months was either normal or below the average. The North Pacific coast region had a very heavy rainfall during April, which continued into May, while for the other months the variations either above or below the normal were slight. The rainfall during June, July, and August, the hottest months of the year, was generally below the average, and the damage resulting from this deficiency in many sections of the country was considerable.

The complete records of temperature and rainfall, both normal and actual, by months, for the various districts of the country, are presented in the two following tables:

Temperature.

Districts.	April.		May.		June.		July.		August.		September.	
	Normal.	1893.	Normal.	1893.	Normal.	1893.	Normal.	1893.	Normal.	1893.	Normal.	1893.
	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.
New England	43·3	41·7	54·1	53·7	63	62·8	68·6	68·1	67·1	67·8	61·1	58·3
Middle Atlantic States	51·6	52·5	62·4	61·5	70·9	71·7	76·3	76·2	73·5	74·5	67·9	66·3
South Atlantic States	61·4	65	70·2	69·2	76·8	76	80·5	81·1	78·3	77·6	73·8	74·9
Florida Peninsula	......	......	......	......	81·3	80·5	83·3	82·2	82·5	82·2	80·5	80·7
Eastern Gulf States	66·1	68·6	72·6	72·1	78·5	78·0	81·5	82·1	79·8	80·1	75·8	76·9
Western Gulf States	66·9	69·7	73·3	72·4	79·5	78·9	82·9	82·7	81·1	80·5	76	78·4
Ohio Valley and Tennessee	55·9	57·7	65·4	63·1	73·4	73·6	77·6	79	74·4	75	68·6	70
Lower Lake Region	44·3	43·9	56·2	54·6	65·9	69·1	71·8	71·9	68·4	69·2	62·3	61·5
Upper Lake Region	40·4	38·6	51·6	49·6	61·6	65·2	68·3	69·1	65·3	65·8	58·6	58·6
Extreme Northwest	40·6	39·3	53·4	52	63·6	66·2	68·5	68·8	65·8	66·7	55·4	57·6
Upper Mississippi Valley	51·3	48·7	61·6	58·9	70·4	72·7	75·9	77	72·2	72·2	64·4	66·9
Missouri Valley	50·6	47·8	61	58	70·5	71·9	75·7	76	72·3	71·5	64·1	67·7
Northern Slope	45·5	39·9	54·3	52·7	63·9	63·6	70·2	71	68·4	68·1	58·5	59·2
Middle Slope	51·7	50·7	59·4	56·8	68·9	70·4	74·6	75	71·4	70·3	63·7	66
Southern Slope	57·2	62	64·4	65·4	71·2	74·9	75·8	77·4	73	72·8	66·8	69·8
Southern Plateau	61·6	60·4	69·6	67·7	77·7	79·5	82·7	80·9	80·6	79·5	73·6	72·3
Middle Plateau	49	44·7	56·9	54·4	65·7	65·6	72·1	72·3	71·3	70·6	61·7	60·5
Northern Plateau	52·2	46·2	59·7	55·3	64·8	59·8	72·1	69·7	71·3	71·1	61·6	60·7
North Pacific Coast Region	49·7	45·3	54·3	51·9	58·1	54·9	61·1	60	60·8	60·8	57·4	55·4
Middle Pacific Coast Region	56·5	52·6	61·1	59·2	64·5	63	67·3	66·7	67·7	66·7	64·3	62
South Pacific Coast Region	59·6	57·6	62·5	61·8	66·1	64·8	69·4	68·5	71·1	70·7	71·1	66·4

Precipitation.

Districts.	April.		May.		June.		July.		August.		September.	
	Normal.	1893.	Normal.	1893.	Normal.	1893.	Normal.	1893.	Normal.	1893.	Normal.	1893.
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
New England	3·25	3·65	3·43	4·73	3·23	2·43	3·76	1·86	4·24	4·94	3·46	2·36
Middle Atlantic States	3·37	3·47	3·46	4·86	3·78	3·78	4·55	3·15	4·84	4·74	4·03	4·23
South Atlantic States	3·76	1·66	4·02	4·42	5·09	6·79	6·36	4·06	6·65	8·85	5·37	4·77
Florida Peninsula	......	......	......	......	......	......	5·61	3·61	4·16	2·76	7·28	3·48
Eastern Gulf States	5·07	3·27	4·46	5·56	5·44	4·84	5·45	3·95	5·65	5·15	4·62	5·02
Western Gulf States	4·07	4·07	4·51	5·71	3·79	4·69	3·08	1·58	3·58	2·48	4·66	1·76
Ohio Valley and Tennessee	4·02	6·22	3·86	6·26	4·34	4·04	4·09	2.49	2·04	1·84	3·17	3·17
Lower Lake Region	2·36	3·76	3·31	4·51	3·36	2·06	3·30	2	3·01	3·51	3·08	1·58
Upper Lake Region	2·36	3·76	3·38	2·78	3·89	2·89	3·31	3·31	3·15	1·45	3·57	2·17
Extreme Northwest	1·71	1·81	2·28	2·28	3·46	3·86	2·92	2·12	2·13	1·63	1·59	·79
Upper Mississippi Valley	2·82	6·32	4·15	4·25	4·95	3·75	3·71	2·41	3·19	1·19	3·58	3·08
Missouri Valley	3·12	4·52	4·62	3·62	4·48	3·88	4·28	4·28	3·55	2·15	2·68	2·48
Northern Slope	1·50	1·20	2·47	2·27	2·82	1·72	1·90	1·20	1·48	1·18	1·05	1·15
Middle Slope	2·39	·59	3·35	2·25	2·33	1·93	2·76	2·86	2·83	1·73	1·42	1·02
Southern Slope	2·54	·14	2·65	3·25	2·32	·72	2·44	2·04	2·85	4·05	2·58	2·88
Southern Plateau	·30	T.	·26	·86	·40	T.	1·76	1·76	1·71	2·81	·94	1·24
Middle Plateau	1·58	1·48	1·07	·77	·55	·05	·49	·59	·82	1·02	·64	·94
Northern Plateau	1·32	3·92	1·57	2·77	1·60	·40	·59	·29	·44	·04	·76	1·96
North Pacific Coast Region	3·44	8·74	2·78	4·08	2·22	3·02	1·18	·58	1·21	·51	3·45	3·85
Middle Pacific Coast Region	2·77	2·67	1·46	1·06	·69	·09	·01	·01	0	0	·41	1·01
South Pacific Coast Region	1·20	·20	·48	·28	·12	·02	T.	T.	·10	0	·10	T.

From the data presented in these two tables there has been compiled a statement showing the aggregate rainfall during the six months, April to September, 1893, the average or normal rainfall for the same period, and the excess or deficiency of the actual rainfall as compared with the normal. For the purpose of comparison the corresponding data for 1892 are also included in the table. In the growing season of 1892 the weather was characterized by an excess of moisture except on the Atlantic coast and in the Western Gulf States. These conditions were generally reversed during 1893. It has already been stated that there was a general deficiency of moisture, which was attributable chiefly to the cloudless skies of June, July, and August. In this connection it may be worth noticing that throughout Western Europe there prevailed a severe and long-continued drought earlier in the season, which totally or partially ruined the hay crop in many parts of Germany, France, Belgium, and England.

The statement showing the aggregate rainfall for the principal agricultural districts during the six months, April to September, 1893, as compared with 1892, is presented in the following table:

Aggregate rainfall for the period April–September.

Districts.	1892.			1893.		
	Normal.	1892.	Departure from the normal.	Normal.	1893.	Departure from the normal.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
New England	22·47	18·87	−3·60	21·37	19·97	−1·40
Middle Atlantic States	23·95	22·35	−1·60	24·03	24·23	+·20
South Atlantic States	31·56	26·86	−4·70	31·25	30·55	−·70
Eastern Gulf States	30·54	30·94	+·40	30·69	27·79	−2·90
Western Gulf States	24·17	22·67	−1·50	23·69	20·29	−3·40
Ohio Valley and Tennessee	23·41	26·51	+3·10	21·52	24·02	+2·50
Lower Lake Region	18·83	25·33	+6·50	18·42	17·42	−1·00
Upper Lake Region	19·40	20·30	+·90	19·66	16·86	−3·30
Extreme Northwest	14·18	14·88	+·70	14·09	12·49	−1·60
Upper Mississippi Valley	22·46	28·76	+6·30	22·40	21·00	−1·40
Missouri Valley	22·57	23·27	+·70	22·73	20·93	−1·80
North Pacific Coast Region	14·96	18·86	+3·90	14·28	20·78	+6·50

The aggregate excess or deficiency in rainfall during the growing season is in itself not sufficient to serve as as index of success in the growth of the farmer's crops. An aggregate deficiency, however large, does not necessarily indicate that the crops have been suffering for want of rain. If, e. g., the supply of moisture during April, May, June, and July has been about normal, and the deficiency occurred during August and September, conditions for crop growth may be considered favorable, although the shortage in the aggregate precipitation would seem to indicate the contrary. It will thus be seen that the distribution of the rainfall is quite as important a factor as the total supply. The appended table shows the departures of temperature and rainfall from the normal for the six months, April to September, 1893.

Departure of temperature and precipitation from the normal.

Districts.	April.		May.		June.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	° *F.*	*Inches.*	° *F.*	*Inches.*	° *F.*	*Inches.*
New England	−1·6	+ ·4	− ·4	+1·3	− ·2	− ·8
Middle Atlantic States	+ ·9	+ ·1	− ·9	+1·4	+ ·8	·0
South Atlantic States	+3·6	−2·1	−1·0	+ ·4	− ·8	+1·7
Florida Peninsula	....	....	....	....	− ·8	....
Eastern Gulf States	+2·5	−1·8	− ·5	+1·1	− ·5	− ·6
Western Gulf States	+2·8	0	− ·9	+1·2	− ·6	+ ·9
Ohio Valley and Tennessee	+1·8	+2·2	−2·3	+2·4	+ ·2	− ·3
Lower Lake Region	− ·4	+1·4	−1·6	+1·2	+3·2	−1·3
Upper Lake Region	−1·8	+1·4	−2	− ·6	+3·6	−1
Extreme Northwest	−7·3	+ ·1	−1·4	0	+2·6	+ ·4
Upper Mississippi Valley	−2·6	+3·5	−2·7	+ ·1	+2·3	−1·2
Missouri Valley	−2·8	+1·4	−3	−1	+1·4	− ·6
Northern Slope	−5·6	− ·3	−1·6	− ·2	− ·3	−1·1
Middle Slope	−1·	−1·8	−2·6	−1·1	+1·5	− ·4
Southern Slope	+4·8	−2·4	+1	+ ·6	+3·7	−1·6
Southern Plateau	−1·2	− ·3	−1·9	+ ·6	+1·8	− ·4
Middle Plateau	−4·3	− ·1	−2·5	− ·3	− ·1	− ·5
Northern Plateau	−6·	+2·6	−4·4	+1·2	−5	−1·2
North Pacific Coast Region	−4·4	+5·3	−2·4	+1·3	−3·2	− ·8
Middle Pacific Coast Region	−3·9	− ·1	−1·9	− ·4	−1·5	− ·6
South Pacific Coast Region	−2·	−1	− ·7	− ·2	−1·3	− ·1

Districts.	July.		August.		September.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	° *F.*	*Inches.*	° *F.*	*Inches.*	° *F.*	*Inches.*
New England	− ·5	−1·9	+ ·7	+ ·7	−2·8	−1·1
Middle Atlantic States	− ·1	−1·4	+1	− ·1	−1·6	+ ·2
South Atlantic States	+ ·6	−2·3	− ·7	+2·2	+1·1	− ·6
Florida Peninsula	−1·1	−2	− ·3	−1·4	+ ·2	−3·8
Eastern Gulf States	+ ·6	−1·5	+ ·3	− ·5	+1·1	+ ·4
Western Gulf States	− ·2	−1·5	− ·6	−1·1	+2·4	−2·9
Ohio Valley and Tennessee	+1·4	−1·6	+ ·6	− ·2	+1·4	0
Lower Lake Region	+ ·1	−1·3	+ 8	+ ·5	− ·8	−1·5
Upper Lake Region	+ ·8	0	+ ·5	−1·7	0	−1·4
Extreme Northwest	+ ·3	− ·8	+ ·9	− ·5	+2·2	− ·8
Upper Mississippi Valley	+1·1	−1·3	0	−2	+2·5	− ·5
Missouri Valley	+ ·3	0	− ·8	−1·4	+3·6	− ·2
Northern Slope	+ ·8	− ·7	− ·3	− ·3	+ ·7	+ ·1
Middle Slope	+ ·4	+ ·1	−1·1	−1·1	+2·3	− ·4
Southern Slope	+1·6	− ·4	− ·2	+1·2	+3	+ ·3
Southern Plateau	−1·8	0	−1·1	+1·1	−1·3	+ ·3
Middle Plateau	+ ·2	+ ·1	− ·7	+ ·2	−1·2	+ ·3
Northern Plateau	−2·4	− ·3	− ·2	− ·4	− ·9	+1·2
North Pacific Coast Region	−1·1	− ·6	0	− ·7	−2	+ ·4
Middle Pacific Coast Region	− ·6	0	−1	0	−2·8	+ ·6
South Pacific Coast Region	− ·9	0	− ·4	− ·1	−4·7	− ·1

MONTHLY RECORD.

April.—In the South Atlantic and Gulf States, and on the Southern Slope, the month was warmer than the average, the latter section reporting the warmest April on record. In nearly all the other sections the temperature was below the average, the extreme Northwest and the Middle and Northern Plateau reporting the coldest April on record. In the South Atlantic, Eastern Gulf States, and the Southern Slope the month was unusually dry; while cold and wet weather interfered with farming operations in New York, the Ohio, Upper Mississippi and Missouri valleys, and in western Colorado, Utah, and Washington. Heavy snowstorms were reported in New England and New York on the 7th, the Northwestern States on the 11th, 12th, 19th, and 20th, the Cascade Mountain region and Washington on the 20th and 21st.

May.—The month was colder than usual, except on the Southern Slope. Frost was reported as far south as the northern parts of the South Atlantic and Eastern Gulf States on the 4th and 17th to 19th, and central Arkansas on the 2d, 3d, and 17th. Rainfall exceeded the normal except in the Upper Lake Region, the Missouri Valley, the Northern and Middle Slope, and California. The effects of drought began to be felt in central and western Kansas, the small grain and grass crops being damaged by the want of rain.

June.—The temperature during this month was above normal from the interior of the Middle Atlantic States, over the Lake Region and Mississippi Valley, Minnesota and the Dakotas, and the Southwest. At some of these localities the month was the warmest June on record. Frost was reported in New England on the 8th and 29th, in central Ohio and lower Michigan on the 7th. The rainfall was generally below the average, except in the South Atlantic, the Western Gulf States, the extreme Northwest, and the North Pacific Coast Region. At stations in southeastern Virginia and eastern South Carolina the monthly rainfall was the greatest on record for June. Hot winds damaged crops in central Nebraska on the 7th, in South Dakota on the 8th and 29th, and in North Dakota on the 19th and 23d.

July.—This month was colder than usual in New England, the Middle Atlantic States, Florida, the Western Gulf States, and on the Pacific Slope. In the other sections the temperature was above normal, being the highest on record for this month at places in North Carolina, Kentucky, and central Texas. The month was exceptionally dry over the greater part of the country. The drought damaged crops in the Atlantic States, Alabama, the Ohio Valley and Tennessee, southeastern Missouri, Arkansas, central Texas, southern Kansas, western Nebraska, southwestern Dakota, Utah, and Idaho.

August.—The temperature did not vary greatly from the normal, the largest departures being 1 degree above normal in the Middle Atlantic States and 1·1 degree below normal in the Middle Slope and Southern Plateau. The rainfall was below the average, except in New England, the South Atlantic States, and the Lower Lake Region. The injurious drought of the preceding month thus continued to the middle of August, and had generally lasted from eight to eleven weeks, before it was broken by rains in Kentucky, Illinois, Indiana, Ohio, Michigan, and Missouri. A hurricane that passed along the Atlantic coast during the last part of the month did much damage in the South Atlantic States. The destruction to crops and property exceeded $3,000,000, and there was a loss of human life aggregating nearly 2,000.

September.—The month was warmer than usual throughout the interior of the country. On the Pacific Coast it was below normal. The

rainfall was above normal in Maine, the interior of North Carolina, northern Georgia, western Tennessee and Kentucky, southeastern Louisiana, and southwestern Alabama. A protracted drought prevailed over all sections of Nebraska from the 1st to the 20th of September. In Ohio the drought was reported as damaging pastures and crops.

CROP REVIEW.

WHEAT.

The condition of the crop 1892-'93, as reported in December, 1892, was 87·2. The condition for the same month—December—in the year 1890 was 98·4, and the succeeding crop of 1890-'91 was 611,780,000 bushels. In December, 1891, the condition of the crop was 85·3, or 13 points lower than that of the previous year. The succeeding harvest showed a total yield of 515,949,000, which is a little over 84 per cent of the crop of 1891. If the December condition of winter wheat governed the prognosis of the succeeding harvest, the crop of 1892-'93 should have been, in round numbers, 407,000,000 bushels instead of 396,000,000, as reported. A very considerable portion of the area was sown late, and the winter was generally unfavorable to the crop.

In New York the conditions were generally good at time of seeding, though the latter part of the fall was dry, checking growth. The winter, however, was favorable, being equable and, through a generous supply of snow spread over a large territory, affording ample protection and insuring good condition for an early and vigorous start. Much the same conditions existed in New Jersey, for, although less top was formed in autumn than usual, the protection from snow kept the crop in excellent state for growth in early spring. In neither of these States was there any damage from fly worth noting. The soil in Maryland, Virginia, and North Carolina was generally too dry for seeding and germination, but in all of these States the snow covering was good during most of the winter, which, on the whole, was severe. In these States the crop emerged from its winter coverings looking well. In South Carolina the soil was in favorable condition for planting, except in sections where the drought in the early part of the planting season and the cold of the latter part retarded germination and growth. In Arkansas the plants wintered only fairly well, and as there was but little snow protection, they were exposed to alternate thawing and freezing. The sowing was late in many localities by reason, first, of drought and, later on, wet weather, which made preparation of the soil more than usually difficult. In the South generally the winter conditions were not unfavorable. In Kentucky the soil generally was too dry for successful seeding and germination. There were a few counties, however, that presented notable exceptions.

In Ohio the seeding season was too dry for the proper preparation of the seed bed. In some localities the seed did not come up, while in most others the germination was slow, and the plant entered the winter under unfavorable auspices. The seeding conditions in the States of Michigan, Indiana, Illinois, and Iowa were much the same in the fact of a generally deficient moisture, resulting in tardiness of germination and weak growth to the very edge of the winter; and in these States the winter was severe. In Missouri sowing was generally two weeks later than usual because of the prevalent dryness, and the soil was dry and cloddy. The rains of October improved the condition of the early sown, but grain sown afterwards did not get a sufficiency of growth and

strength to enable it to withstand the severe cold of the winter. It therefore came forth in early spring in a weakened condition and much of it was winter-killed. In Kansas the ground throughout the State, except in a few localities, was too dry for a proper preparation of the seed bed, and the weather being both dry and cold during the winter, germination and growth were seriously retarded. In the western and some of the central counties where the planting was late the seed had not sprouted so late as April, and some did not sprout at all. During the winter in what is known as the "wheat belt" of the State there was very little protection from snow, and the crop came from its "winter quarters" in a poor condition.

The fall conditions in Nebraska were of the same general character as those which prevailed through the western wheat belt. Early sown entered winter in fair condition, but most of the late sown was slow in germination (much of it never sprouted at all), and entered upon winter in a comparatively feeble state. This was due almost entirely to the effects of drought upon the soil. In Washington and Oregon the winter protection was excellent, but the fall was dry and germination thereby affected adversely. In California, owing to the irregular and inopportune fall of rain, the general condition of the soil for seeding and germination was not favorable. In some parts the weather was too wet, in others too dry, and in others unseasonable.

Throughout the Eastern, Middle, and Northwestern States the crop was generally well covered with snow, but over large areas the benefit thus afforded was fully offset by the excessively cold winter, high winds, which in some regions tore the crop from its bed, and the alternate thawing and freezing which occurred over extensive areas during the months of February and March. As it was, the early spring condition was very low compared with the records of previous years, in fact only 1·4 per cent higher than that of 1885, which was the lowest April condition ever reported. The May and June reports showed a decline from the low April condition. In July there was a slight rally, bringing the indications up a very slight fraction above the gloomy spring prospects, followed by a steady decline thereon until harvest time.

One effect of the drought and the severe winter was the abandonment of a very considerable portion of the area sown and the substitution of other crops. This was done notably in the States of Missouri, Kansas, Nebraska, Indiana, and Illinois, and to some extent in other States. Some damage from the Hessian fly occurred in a few States, Ohio, Indiana, Illinois, and Michigan being among the number, and from the chinch bug in Kansas.

In the spring-wheat region sowing was generally late because of a cold, backward, unfavorable spring, and in consequence of this fact and the low prices of wheat some reduction of the usual area devoted to the crop was made. In some parts of the region the late seeding and slow germination were due to a lack of moisture, while in others these effects followed cold, wet weather. The month of June showed improvement in condition, but this was succeeded in July by a decided decline, which continued to the end of the season. The condition of both spring and winter wheat at the harvest point was the lowest since 1885.

Condition of winter wheat.

Year.	April.	May.	June.	July.	September.
1892	81·2	84	88·3	89·6	87·6
1893	77·4	75·3	75·5	77·7	76·3

CORN.

The corn crop was planted rather late because at the usual planting time the weather, varying with localities, was either too cold, too wet, or too dry. Nothwithstanding the late planting, the crop made fine progress through the month of June, and the July average of condition was the highest for that month of any year since 1887. The latter part of June or the first of July, however, witnessed the beginning of a season of drought that for prevalence and persistence has not been surpassed, if even equaled, for a number of years. After July a pronounced decline in the condition of the crop was manifest, and this decline continued without interruption to the harvest time.

The October report showed a falling off from the July returns of condition of over 18 points. The unfavorable conditions of the season were, however, somewhat compensated by an increase of acreage, as compared with the previous year. This increase as shown by the July returns was not net. A very considerable subtraction therefrom must be allowed, as much of the crop planted was cut for fodder or failed outright, so that the aggregate yield was not improved thereby. The quality of the crop varied greatly in the principal maize States from "worthless" to "the best crop," and the yield from 5 to 60 bushels per acre. This variation was due, to no inconsiderable extent, to the condition of the soil when the corn was planted and the drought struck it. The soils that were best prepared for planting withstood the dry season much the best, illustrating the advantages to be gained from thorough cultivation.

The condition of corn as reported for the years 1892 and 1893 is shown in the following table:

Condition of corn.

Year.	July.	August.	September.	October.
1892	81·1	82·5	79·6	79·8
1893	93·2	87	76·7	75·1

The following table, showing condition in the principal maize-producing States for the same years, is given for further comparison:

States.	July.		August.		September.		October.	
	1892.	1893.	1892.	1893.	1892.	1893.	1892.	1893.
New York	90	93	90	92	89	86	87	85
Virginia	96	96	90	90	78	74	76	76
Georgia	95	97	97	88	98	89	95	86
Texas	95	89	94	75	93	71	93	76
Tennessee	92	92	92	86	92	76	89	75
Kentucky	93	90	90	86	83	75	81	73
Ohio	80	93	81	85	79	64	80	70
Indiana	72	96	74	79	75	59	77	61
Illinois	70	92	73	81	70	64	71	66
Iowa	75	98	79	102	78	96	79	93
Missouri	75	92	83	95	82	92	82	89
Kansas	81	93	81	82	70	73	70	64
Nebraska	84	94	80	84	76	71	78	65

OATS.

The area devoted to oats has been slightly increased as compared with that of 1892. In condition also the crop started with a slight advantage over that of the previous year, which was not maintained,

however. The fall from June and July conditions (which were 88·9 and 88·8 respectively) as shown by the September returns was rapid and precipitous. There occurred in the brief space of two months a change for the worse of 14 points, and the crop approached harvest with a condition of 74·9 against 88·9 in June, and against 78·9 for the same month (September) in the year 1892.

A comparison of conditions of this year's crop with that of 1892 is as follows:

Condition of oats.

Year.	June.	July.	August.	September.
1892	88·5	87·2	86·2	78·9
1893	88·9	88·8	78·3	74·9

BUCKWHEAT.

Buckwheat, the least of our cereal crops, showed an August condition of 88·8, from which it declined until it stood in October at 73·5, a fall of a little over 15 points. The August returns showed a decrease in the acreage as compared with 1892 of nearly 6 per cent. The product for the year 1893 is about an average one.

RYE.

The general conditions that affected other cereals detrimentally were not so apparent in connection with the rye crop. The average yield per acre as given in the October returns showed an increase over that of the year 1892, being 13·3, against 12·7 bushels in the October report of last year. There was a decrease in the breadth sown, as compared with the previous year, of some 6 points. The June condition was 84·6. The September or harvest condition averaged 82 per cent, a very slight fall compared with that of other grains.

BARLEY.

The June returns indicated a decrease in the breadth devoted to barley of about 5 points. The condition reported in the same month was 88·3 per cent, from which it declined to 83·8 in September, losing but 4½ points during the unfavorable season.

POTATOES.

The first returns relating to the potato crop in July showed an increase of area of a little over 1 per cent over that of 1892. The shortage of the crops and the high prices of the previous years tended to an enlargement of breadth, which was checked, however, in some sections by a scarcity of seed. The reported condition in July was 94·8, about the average for a series of years. The October condition showed a decline since July to 71·2, a fall of 23·6 points. The crop is below an average one, due to the uneven and untimely distribution of moisture.

THE GRASSES.

Owing to the droughty condition in the fall of 1892, the deficient precipitation except on the Pacific slope, during the winter months, and

the unusually cold winter and backward spring, the growth of grass on spring pastures and mowing lands was seriously retarded. Exceptions are to be noted in localities which had the advantage of a continued snow protection. The June returns showed a condition somewhat lower than that of 1892, but higher than at the same date in 1891. There was a range in the New England States from 92 in Rhode Island to 98 in Massachusetts, while New York stood high at plump 100. Southward through the Middle Atlantic States the range of condition was lower. In Georgia and the Gulf States from Alabama to Louisiana inclusive, in Arkansas, Tennessee, and the States of the Ohio Valley, and in Michigan, Wisconsin, and Iowa the condition ranged as high as from 95 to 100 per cent. In the Northwestern States from the Dakotas to the Pacific the range of condition in June was generally high.

In July, in most of the States, the condition of pasturage on the whole was satisfactory, although drought occasioned some deterioration through New Mexico and Arizona and on the plains and tablelands of the interior, thus lowering the average condition for the country as compared with the very high average of July, 1892. The condition in a few of the Atlantic States fell somewhat, as did also that of Kansas and Nebraska, and the territory to the west and southwest of these States. Later on in the month of August the general condition of pasturage declined considerably as a result of the lack of rainfall during the month of July, and in some parts of Indiana, Illinois, Wisconsin, and Minnesota, farmers were compelled, by reason of the destruction of the pasturage, to feed their stock as in winter. In the States of the Atlantic coast, and in parts of West Virginia, Tennessee, and Ohio, the pastures were materially benefited in September, by timely rains. Some improvement also occurred in portions of Kansas, Colorado, and the Territories of Utah and Arizona.

The June returns showed a reduction of area as compared with the previous year of 2·5 per cent, while the report of condition was 92·7 as compared with 94·9 the same month the year before. In July the condition stood at 92·6 as compared with 95·5 of the year 1892. The condition was lowest in old fields exposed to the drought of the autumn of the previous year and the severities of the winter following. The condition of timothy stood in July at 89·8, while for that month in 1892 it was 96·8, a difference of 7 points. Its condition through the season corresponded with that of pasturage. Notwithstanding the low average of condition as compared with the previous year, November returns showed the average yield of hay to be 1·32 tons per acre as against 1·17 tons per acre in 1892. The explanation lies in the large amount of alfalfa included in the term, the yield per acre of this fodder plant being much greater than that of the cultivated grasses.

COTTON.

The cotton acreage, in 1892, according to the report of the Statistician for that year was heavily reduced by reason of the "discouraging effect of low prices, etc."

This year's returns show an increase of that acreage as compared with the reduced area of 1892. The May returns showed that 85·3 per cent of the proposed breadth was planted by the first of that month, which is about the usual proportion for that date. Where retarded planting was reported the causes were indicated as drought, frost, or excessive rain according to locality. The weather conditions at this time were generally unfavorable to germination and growth. The reports as to

contemplated acreage were of a dubious character, so much so that it was impossible to foreshadow the final results thereby. The June returns were not of an inspiring character, the condition of the plant being 85·6, which, however, was but three-tenths of a point lower than the condition reported for June, 1892. A decline of nearly 3 points from this figure was shown by the July reports, the assigned causes being low temperature, cool nights, drought, spots, and injuries done by lice and other insects, overflows, etc.

In August the condition had declined from that of the previous month a little over 2 points, standing at 80·4 against 82·7. This was the lowest August average ever reported by the Department. The September condition showed a continued decline, being 73·4, or 7 full points below that of August, and the lowest September condition since 1881, when it stood at 70. In addition to unfavorable weather conditions, prominent among which was drought, the correspondents ascribed the decline of condition to the attacks of insects, such as caterpillar and the boll, army, and leaf worms, and to some extent to rust. The persistency of the retrogressive tendency in condition was still further manifested by the returns of October, which gave a condition of 70·7 per cent, a fall of 14·8 points since June. As was expected from these returns, the November reports did not indicate a high rate of yield and pointed to a diminished harvest compared with even the poor yield of 1892. The advices subsequently received, together with reports of individual planters or farmers, justify a moderate increase in the statement of yield over that indicated in the November returns.

TOBACCO.

The tobacco crop started out in July with most promising condition, the returns indicating 93 per cent, a higher average than had occurred in the four years 1889 to 1892, inclusive. From this elevation it fell to 82·2 per cent in August and to 73·3 in September, the lowest condition for several years. A slight rally was reported in October, due to better meteorological conditions during September, but which came too late to repair the serious damages of the prior conditions. The October condition was 74 per cent, a net fall from that of July of 19 points. The yield, 687 pounds per acre, is lower than the usual yield; it is 5 pounds above the average yield for 1892 and 61 pounds lower than the average for 1891. The yield per acre in the seed-leaf growing States is, as usual, larger than in the States growing heavy tobaccos.

FRUITS.

The season of 1893 has been a poor one for the growth of large fruits. The monthly reports pointed to failure from the first. The elements have been adverse. Frosts, wet, droughts, and winds have successively and in turn interfered with bloom, set, growth, and maturity. At time of harvest many orchards were almost bare of fruit.

PRINCIPAL CROPS, 1893.

CORN.

The area devoted to corn as estimated for the crop of 1893 makes an increase over that of 1892 of 1,409,807 acres, and is less by 40,737 acres than the census crop of 1889. The aggregate estimate for the year is 72,036,465 acres, or 1,493,008 acres above the average for the ten years

1880 to 1889, and 897,514 acres below the average acreage of the three years 1890–1892, which included the unusually large area of 76,204,515 acres in 1891. The estimates of area, product, and value are given in the following table:

Area, product, and value of corn, 1893.

States and Territories.	Acres.	Bushels.	Value.
Maine	13, 553	410, 656	$254, 607
New Hampshire	25, 074	794, 846	453, 062
Vermont	44, 094	1, 428, 646	871, 474
Massachusetts	40, 460	1, 355, 410	840, 354
Rhode Island	8, 949	218, 356	150, 666
Connecticut	43, 557	1, 228, 307	786, 116
New York	517, 135	15, 255, 483	8, 390, 516
New Jersey	277, 183	7, 179, 040	3, 733, 101
Pennsylvania	1, 273, 418	31, 198, 741	15, 287, 383
Delaware	199, 874	4, 916, 900	1, 966, 760
Maryland	623, 067	15, 078, 221	6, 634, 417
Virginia	1, 652, 595	31, 234, 046	14, 367, 661
North Carolina	2, 435, 310	29, 954, 313	14, 977, 157
South Carolina	1, 623, 511	12, 501, 035	7, 500, 621
Georgia	3, 034, 079	33, 678, 277	18, 859, 835
Florida	506, 120	4, 909, 364	3, 338, 368
Alabama	2, 463, 349	28, 328, 514	16, 713, 823
Mississippi	1, 970, 777	25, 817, 179	14, 199, 448
Louisiana	1, 071, 568	15, 216, 266	8, 673, 272
Texas	3, 475, 623	61, 170, 965	33, 032, 321
Arkansas	1, 982, 149	32, 110, 814	14, 449, 866
Tennessee	2, 988, 247	63, 649, 661	24, 823, 368
West Virginia	649, 265	14, 089, 051	7, 748, 978
Kentucky	2, 893, 960	68, 008, 060	29, 243, 466
Ohio	2, 769, 549	64, 487, 266	25, 794, 906
Michigan	919, 432	21, 790, 538	9, 805, 742
Indiana	3, 456, 226	85, 368, 782	30, 732, 762
Illinois	6, 247, 100	160, 550, 470	49, 770, 646
Wisconsin	971, 686	28, 956, 243	10, 134, 685
Minnesota	887, 052	25, 103, 572	8, 535, 214
Iowa	7, 428, 677	251, 832, 150	67, 994, 681
Missouri	5, 670, 169	158, 197, 715	47, 459, 315
Kansas	6, 547, 263	139, 456, 702	43, 231, 578
Nebraska	6, 241, 226	157, 278, 895	42, 465, 302
South Dakota	865, 472	20, 511, 686	5, 127, 922
North Dakota	20, 142	416, 939	158, 437
Montana	1, 102	30, 305	21, 214
Wyoming	2, 071	38, 314	24, 138
Colorado	123, 107	2, 031, 266	1, 035, 946
New Mexico	25, 155	636, 422	451, 860
Arizona	4, 604	81, 951	54, 088
Utah	8, 575	184, 363	106, 931
Nevada			
Idaho	1, 628	31, 746	22, 540
Washington	8, 405	179, 027	110, 997
Oregon	13, 132	324, 360	152, 449
California	71, 775	2, 275, 268	1, 137, 634
Total	72, 036, 465	1, 619, 496, 131	591, 625, 627

The average rate of yield, 22·5 bushels per acre, is the lowest for ten years, with the exception of the years 1886, 1887, and 1890. It is only a little lower, however, than that of 1883, which was 22·7, or two-tenths of a bushel greater. The average value per bushel is 36·5 cents, which is 2·9 cents, or about 7 per cent lower than the value of 1892. This value is 6·1 cents less than the average of the ten years 1870–1879, 2·8 cents less than that of the decade 1880–1889, and 6·6 cents below the average value of the three years 1890–1892. In the ten years preceding, only four crops, viz, those of 1884 (35·7), 1885 (32·8), 1888 (34·1), and 1889 (28·3) have had a lower average value.

Only two crops in the ten years 1884–1893 have been smaller, those of 1887 and 1890, the total crops of these years, respectively, having been 1,456,161,000 and 1,489,970,000 bushels.

The total value of the crop, $591,625,627, is less than the value of the smaller crops of 1887 and 1890, $54,481,143 less than that of the

first of these years, and $162,807,824 less than that of the second; and although the crop is only about 9,000,000 bushels less than that of 1892, its money value on the farm is over $50,500,000 less. The value per acre is $8.21, the lowest for ten years, except for the years 1886 and 1889.

The following table shows the breadth, product, value (farm), average yield per acre and average value per bushel and per acre of corn for the past fourteen years:

Corn crops of the fourteen years, 1880–1893, with averages for two decades.

Year.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1880	1,717,434,543	62,317,842	$679,714,499	39.6	27·6	$10.91
1881	1,194,916,000	64,262,025	759,482,170	63.6	18·6	11.82
1882	1,617,025,100	65,659,545	783,867,175	48.5	24·6	11.94
1883	1,551,066,895	68,301,889	658,051,485	42.4	22·7	9.63
1884	1,795,528,000	69,683,780	640,735,560	35.7	25·8	9.19
1885	1,936,176,000	73,130,150	635,674,630	32.8	26·5	8.69
1886	1,665,441,000	75,694,208	610,311,000	36.6	22	8.06
1887	1,456,161,000	72,392,720	646,106,770	44.4	20·1	8.93
1888	1,987,790,000	75,672,763	677,561,580	34.1	26·3	8.95
1889	2,112,892,000	78,319,651	597,918,829	28.3	27	7.63
Total	17,034,430,538	705,434,573	6,689,423,698			
Average for 10 years—1880 to 1889	1,703,443,054	70,543,457	668,942,370	39.3	24·1	9.48
Average for 10 years—1870 to 1879	1,184,486,954	43,741,331	504,571,018	42.6	27·1	11.54
1890	1,489,970,000	71,970,763	754,433,451	50.6	20·7	10.48
1891	2,060,154,000	76,204,515	836,439,228	40.6	27	10.98
1892	1,628,464,000	70,626,658	642,146,630	39.4	23·1	9.09
1893	1,619,496,131	72,036,465	591,625,627	36.5	22·5	8.21
Total	6,798,084,131	290,838,401	2,824,644,936			
Average for 4 years—1890 to 1893	1,699,521,033	72,709,600	706,161,234	41.6	23·4	9.71

The following table gives the production and exports of corn for the past twenty-three years, 1870 to 1892, inclusive. The exports of corn, including meal, during this period have averaged 3·8 per cent of the crop. The sale of corn in Europe depends principally upon its relative cost as a food for animals. As yet, maize is not used to any considerable extent in Europe as human food, although very strenuous efforts have been and are being made by this Government to acquaint the people of the other side with the edible qualities and the great value of this cereal as a nutrient.

Production and exports of corn, 1870–1892.

Years.	Production.	Experts.	Exportation.	Years.	Production.	Exports.	Exportation.
	Bushels.	*Bushels.*	*P. ct.*		*Bushels.*	*Bushels.*	*P. ct.*
1870	1,094,255,000	10,673,553	1	1883	1,551,066,895	46,258,606	3
1871	991,898,000	35,727,010	3·6	1884	1,795,528,000	52,876,456	2·9
1872	1,092,719,000	40,154,374	3·7	1885	1,936,176,000	64,829,617	3·3
1873	932,274,000	35,985,834	3·9	1886	1,665,441,000	41,368,584	2·5
1874	850,148,500	30,025,036	3·5	1887	1,456,161,000	25,360,869	1·7
1875	1,321,069,000	50,910,532	3·9	1888	1,987,790,000	70,841,673	3·6
1876	1,283,827,500	72,652,611	5·7	1889	2,112,892,000	103,418,709	4·9
1877	1,342,558,000	87,192,110	6·5	1890	1,489,970,000	32,041,529	2·2
1878	1,388,218,750	87,884,892	6·3	1891	2,060,154,000	76,602,285	3·7
1879	1,754,591,676	99,572,329	5·7	1892	1,628,464,000	47,119,524	2·9
1880	1,717,434,543	93,648,147	5·5				
1881	1,194,916,000	44,340,683	3·7	Annual average.	1,489,764,250	56,136,549	3·8
1882	1,617,025,100	41,655,653	2·6				

In the above table, it must be understood that the figures of production are for the respective calendar years, while those of exports are for the fiscal years ending June 30 of the year following.

As an auxiliary to the methods adopted by the Department to approximate crop facts, returns are obtained from a selected list of farmers. These reports from representative farmers differ in results, to some extent, from those obtained from the general survey, but not more than would be expected, considering their exceptional sources, and on the whole they are strongly corroborative of the correctness of the returns from the wider range. Returns from individual corn growers this year have been received from 39,184 persons, embracing a total of 1,568,465 acres producing 40,552,646 bushels, the yield per acre being 25·9 bushels. The report from the same source in 1892 was from 50,000 farmers and covered an aggregate of 1,689,081 acres, with a yield of 45,477,652 bushels, or 26·8 bushels per acre. The area reported in 1891 was 1,621,284 and the yield per acre 28·7 bushels. The October condition of the three years, 1891, 1892, and 1893, respectively, was 92·5, 79·8, and 75·1 per cent.

Yields of corn per acre as shown by returns from selected farmers.

States and Territories.	1890.	1891.	1892.	1893.	States and Territories.	1890.	1891.	1892.	1893.
Maine	38	44·6	41·6	35·7	Indiana	30·2	39	34·7	26·7
New Hampshire	44·6	45·7	43·2	47·3	Illinois	33·8	40·7	33	30·6
Vermont	43	44	42·7	45·6	Wisconsin	35	29·2	23·3	37
Massachusetts	43·4	42·9	37·7	37·5	Minnesota	25·6	29·3	30	31·8
Rhode Island	38·4	25·3	36·1	32·4	Iowa	27·9	41	34	40
Connecticut	42·4	43	43·1	51·7	Missouri	30·3	32·9	31·2	33·8
New York	29·6	38·5	37·9	34	Kansas	12·8	28·8	26·3	21·1
New Jersey	39·3	43·4	48·9	31·5	Nebraska	12·5	39·1	33·5	24·2
Pennsylvania	36·6	44·3	34·8	31·1	South Dakota	10·9	23·5	21·4	22·6
Delaware	19·9	30·4	31·3	24·2	North Dakota		18·1	23·8	18·3
Maryland	35·2	43·6	32·8	30·5	Montana	13·6	27·8	31	21·8
Virginia	23·2	27·7	22·4	23·3	Wyoming	28·3	38	23·3	22·5
North Carolina	19·3	17·2	15·4	16	Colorado	10·3	23·5	21·7	9·6
South Carolina	12·7	12·2	12·9	10·5	New Mexico	20·5	20·6	19·3	10·7
Georgia	12·5	13·3	12·9	12·4	Arizona	14·7	23·4	25·2	24·7
Florida	10	11·4	11·5	13·4	Utah	21·1	19·1	19·5	19
Alabama	17·3	16·2	12·2	12·4	Nevada	11·5	22·5	20·9	41·9
Mississippi	15·9	17·2	17·2	13·9	Idaho	15·6	22·3	22·2	28·1
Louisiana	18·3	20·3	12·5	17·2	Washington	20·6	17·9	10·6	14
Texas	21·4	22·6	23·6	19·4	Oregon	22·4	27·5	19·1	19·3
Arkansas	19	26·1	19·4	20·4	California	22·8	36·4	20·5	23·3
Tennessee	22·9	29·7	27·1	24·7	Oklahoma T	......	25·9	27·6	......
West Virginia	23·3	36·5	31·9	27·3	Indian T	4·8	43·3	21·6	......
Kentucky	24·5	34	29·5	29·1					
Ohio	28·1	34·8	40·3	36·5	Average	23·1	28·7	26·8	25·9
Michigan	29·2	33·3	42·3	28·9					

WHEAT.

As the reported condition of this crop from month to month during the entire season indicated in advance, the crop harvested in 1893 was one of diminished yield. Further investigations, while resulting in a slight increase in the average yield per acre, have substantially confirmed the correctness of the October returns. The total breadth harvested is estimated at 34,629,418 acres, as against 38,554,430 in 1892, a falling off of about 3,925,000 acres. This is the lowest average estimate of acreage in the fourteen years from 1880, inclusive, except that of 1885, and but 440,000 acres more than for that year. It is less by 2,649,744 acres than the average of the period 1880 to 1889, and 3,556,742 acres less than the average of the three years 1890–1892. This diminution in the breadth was due in part to abandonment and a devotion to other crops of parts of the acreage sown, because of the unfavorable winter and the dry summer season. It was also, to some extent, an effect of low

prices. The reduction of area was greatest in such surplus winter-wheat States as Illinois, Missouri, Kansas, and California, and the range of decrease in the spring-wheat States of North and South Dakota and Minnesota was from 5 to 10 per cent.

The total product as estimated amounts to 396,131,725 measured bushels, which is about 3,000,000 bushels less than the crop of 1890, 215,648,275 less than the crop of 1891, and 119,818,275 less than that of 1892. This aggregate production falls below the average for the ten years 1880 to 1889 to the amount of 53,563,634 bushels, and is 84,648,956 bushels less than the average crop for the four years 1890 to 1893, inclusive.

Notwithstanding this remarkable falling off in the total product, there has been a fall in the price per bushel, so that the farm value of the crop is estimated at the comparatively low amount of $213,171,381, which is the lowest recorded since 1863. The average farm price per bushel is estimated at 53.8 cents, making an average farm value per acre to the cultivator of $6.16, which is $6.84 less than the average for the period 1870 to 1879; $3.81 less than the average for the decade 1880–1889, and $3.11 below the average for the four years 1890 to 1893, inclusive.

Area, product, and value of wheat, 1893.

States and Territories.	Acres.	Bushels.	Value.
Maine	4,500	72,000	$73,440
New Hampshire	2,327	34,905	29,669
Vermont	8,225	138,180	117,453
Massachusetts	....	....	....
Rhode Island	....	....	....
Connecticut	....	....	....
New York	472,142	6,846,059	5,203,005
New Jersey	123,701	1,793,665	1,255,566
Pennsylvania	1,310,822	18,351,508	11,928,480
Delaware	99,440	1,461,768	877,061
Maryland	497,903	6,721,691	5,108,485
Virginia	775,097	8,681,086	5,469,084
North Carolina	724,111	5,937,710	4,275,151
South Carolina	147,202	927,373	908,826
Georgia	240,670	1,732,824	1,559,542
Florida	....	....	....
Alabama	47,880	392,616	345,502
Mississippi	3,577	27,543	23,412
Louisiana	....	....	....
Texas	431,732	4,533,186	2,629,248
Arkansas	171,211	1,369,688	890,297
Tennessee	809,024	7,443,021	4,242,522
West Virginia	398,056	4,577,644	3,295,904
Kentucky	936,678	10,584,461	6,033,143
Ohio	2,683,904	38,916,608	22,182,467
Michigan	1,509,145	19,920,714	11,354,807
Indiana	2,523,362	35,579,404	18,857,084
Illinois	1,348,462	15,507,313	7,908,730
Wisconsin	651,465	8,664,485	4,678,822
Minnesota	3,197,363	30,694,685	15,654,289
Iowa	586,889	6,749,224	3,307,120
Missouri	1,609,216	15,287,552	7,338,025
Kansas	2,768,092	23,251,973	9,765,829
Nebraska	1,228,493	10,687,889	4,275,156
South Dakota	2,414,281	20,521,389	9,029,411
North Dakota	2,753,980	26,438,208	11,368,429
Montana	43,431	933,767	560,260
Wyoming	5,082	95,033	61,771
Colorado	137,636	1,816,795	944,733
New Mexico	39,571	664,793	498,595
Arizona	11,000	192,500	125,125
Utah	105,650	1,457,970	874,782
Nevada	5,613	82,511	60,233
Idaho	78,490	1,514,857	908,914
Washington	456,883	9,883,725	4,744,188
Oregon	616,622	10,790,885	5,934,987
California	2,620,490	34,852,517	18,471,834
Total	34,629,418	396,131,725	213,171,381

Wheat crops of the fourteen years, 1880–1893, with averages for two decades.

Years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1880	498, 549, 868	37, 986, 717	$474, 201, 850	95·1	13·1	$12.48
1881	383, 280, 090	37, 709, 020	456, 880, 427	119·2	10·2	12.12
1882	504, 185, 470	37, 067, 194	444, 602, 125	88·2	13·6	11.99
1883	421, 086, 160	36, 455, 593	383, 649, 272	91·1	11·6	10.52
1884	512, 765, 000	39, 475, 885	330, 862, 260	64·5	13	8.38
1885	357, 112, 000	34, 189, 246	275, 320, 390	77·1	10·4	8.05
1886	457, 218, 000	36, 806, 184	314, 226, 020	68·7	12·4	8.54
1887	456, 329, 000	37, 641, 783	310, 612, 960	68·1	12·1	8.25
1888	415, 868, 000	37, 336, 138	385, 248, 030	92·6	11·1	10.32
1889	490, 560, 000	38, 123, 859	342, 491, 707	69·8	12.9	8.98
Total	4, 496, 953, 588	372, 791, 619	3, 718, 095, 041			
Average for 10 years—1880 to 1889	449, 695, 359	37, 279, 162	371, 809, 504	82·7	12·1	9.87
Average for 10 years—1870 to 1879	312, 152, 728	25, 187, 414	327, 407, 258	104·9	12·4	13.00
1890	399, 262, 000	36, 087, 154	334, 773, 678	83·8	11·1	9.28
1891	611, 780, 000	39, 916, 897	513, 472, 711	83·9	15·3	12.86
1892	515, 949, 000	38, 554, 430	322, 111, 881	62·4	13·4	8.35
1893	396, 131, 725	34, 629, 418	213, 171, 381	53·8	11·4	6.16
Total	1, 923, 122, 725	149, 187, 899	1, 383, 529, 651			
Average for 4 years—1890 to 1893	480, 780, 681	37, 296, 975	345, 882, 413	71·9	12·9	9.27

Production and distribution of wheat from 1881 to 1892.

Years.	Production.	For food.*	For seed.	Exportation.	Total distributed.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1881	383, 280, 090	243, 000, 000	55, 215, 573	121, 892, 389	420, 107, 962
1882	504, 185, 470	250, 000, 000	52, 770, 312	147, 811, 316	450, 581, 628
1883	421, 086, 160	256, 000, 000	54, 683, 389	111,534, 182	422, 217, 571
1884	512, 765, 000	261, 000, 000	55, 266, 239	132, 570, 367	448, 836, 606
1885	357, 112, 000	267, 000, 000	51, 474, 906	94, 565, 794	413, 040, 706
1886	457, 218, 000	271, 000, 000	51, 528, 658	153, 804, 970	476, 333, 628
1887	456, 329, 000	277, 000, 000	53, 009, 982	119, 625, 344	449, 635, 326
1888	415, 868, 000	283, 000, 000	54, 012, 702	88, 600, 743	425, 613, 445
1889	490, 560, 000	289, 000, 000	53, 973, 000	109, 430, 467	452, 403, 467
1890	399, 262, 000	295, 000, 000	56, 582, 000	106, 181, 316	457, 763, 316
1891	611, 780, 000	302, 000, 000	54, 508, 000	225, 665, 812	582, 173, 812
1892	515, 949, 000	304, 000, 000	54, 000, 000	191, 912, 635	549, 912, 635
Total	5, 525, 394, 720	3, 298, 000, 000	647, 024, 761	1, 603, 595, 335	5, 548, 620, 096
Average	460, 449, 560	274, 833, 333	53, 918, 730	133, 632, 945	462, 385, 008

* Taking 4⅗ bushels per capita as the average consumption.

The returns of individual wheat-growers (that arrived in time for consolidation) are fewer than last year (1892), the number being 28,193 and representing 1,351,404 acres producing 16,806,124 bushels, or an average of 12·4 bushels per acre. This is just one bushel higher than the average obtained from the consolidated returns. The individual returns of 1892 from 50,000 persons, covering an area of 1,473,500 acres, showed an average of 15·7 bushels, as against 13·4 bushels derived from the general returns. The average obtained from the individual or special returns is always higher than that which results from the consolidation of the returns from State and county correspondents. It is probable that this difference simply reflects the superiority either of the modes of cultivation or the areas cultivated, or both, as

compared with the ordinary. The averages by States of these actual yields as reported for four years past are shown in the table following:

Yields of wheat per acre as shown by returns from selected farmers.

States and Territories.	1890.	1891.	1892.	1893.	States and Territories.	1890.	1891.	1892.	1893.
Maine	19	24·7	23·7	16	Indiana	12·9	21·4	19	14·1
New Hampshire	18·3	24·2	20·2	15	Illinois	12·9	18·3	18·9	11·5
Vermont	17·5	25·1	21·7	16·8	Wisconsin	15·7	16·7	15·9	13·3
Massachusetts	12	17·1	18·5	16·3	Minnesota	12·7	19·9	12·2	9·6
Rhode Island	......	......	13·4	......	Iowa	12·8	17·4	14·6	11·5
Connecticut	18·6	24·3	15·5	......	Missouri	12·9	17·6	14·9	9·5
New York	20·1	22·6	18·8	14·5	Kansas	12·7	14·6	18·2	8·4
New Jersey	15·6	18·5	19·2	14·5	Nebraska	8·3	19·4	16·4	8·7
Pennsylvania	16·6	20·6	16·9	14	South Dakota	6·9	14·4	14·2	8.5
Delaware	13·9	19·8	19	14·7	North Dakota		21·2	14·4	9·6
Maryland	15·5	20·2	18·6	13·5	Montana	22·3	34·9	27·8	21·5
Virginia	8·4	12·8	13·8	11·2	Wyoming	22·9	25·6	22·1	18·7
North Carolina	5·1	7·3	9·2	8·2	Colorado	17·9	21·1	20·3	13·2
South Carolina	4·4	6·8	7·7	6·3	New Mexico	21·0	11	13·8	16·8
Georgia	3	7·5	8·3	7·2	Arizona	15·1	16·8	22·4	17·5
Florida	......	......	10	......	Utah	22·9	22·4	19·7	13·8
Alabama	4·6	9·6	7·9	8·2	Nevada	24·1	27·3	23·9	14·7
Mississippi	2·2	16·9	11·2	7·7	Idaho	22·9	21·8	22·9	19·3
Louisiana	......	14	22·4	......	Washington	24·4	21	18·9	20·3
Texas	7·2	16·5	10·4	10·5	Oregon	20·5	24·7	17·5	17·5
Arkansas	7·9	10	9	8	California	15·9	13·8	15·4	13·3
Tennessee	5·8	13·7	13·8	9·2	Oklahoma	......	14·8	20·7	14·3
West Virginia	10·5	14	8·4	11·5	Indian Territory	......	14·9	25·2	13·7
Kentucky	10·4	15·7	17·4	11·3					
Ohio	15·4	21·6	16·6	14·5	Total	12·6	18	15·7	11·4
Michigan	16	20·6	17·0	13·2					

OATS.

The estimated area of oats shows an increase of about 209,000 acres over the crop of 1892. No advantage, however, was obtained from the enlargement of the area, as the aggregate yield was 22,180,150 bushels less than that obtained from the crop of the year previous. The average yield to the acre was 23·4 bushels against 24·4 in 1892. It was a little more than 3 bushels less per acre than the average yield for the ten years 1880 to 1889, and was slightly less than the average yield of the last four years, 1890 to 1893, inclusive. The farm value of the crop, $187,576,092, was $21,677,519 less than that of 1892. The average value per acre was $6.88, the lowest since 1839, and was $1.34 below that of the decade 1880 to 1889.

Area, product, and value of oats, 1893.

States and Territories.	Acres.	Bushels.	Value.
Maine	123,256	4,474,193	$2,013,387
New Hampshire	28,787	984,515	423,341
Vermont	108,712	3,957,117	1,661,989
Massachusetts	15,280	524,104	220,124
Rhode Island	4,137	116,663	59,165
Connecticut	23,739	593,475	237,390
New York	1,258,697	30,208,728	9,062,618
New Jersey	109,744	2,622,882	918,009
Pennsylvania	1,141,832	30,601,098	10,710,384
Delaware	21,044	534,518	203,117
Maryland	91,458	1,938,910	678,619
Virginia	478,768	8,378,440	2,932,454
North Carolina	544,220	7,673,502	3,376,341
South Carolina	333,145	3,931,111	2,083,489
Georgia	597,593	7,947,987	4,132,953
Florida	51,000	601,800	330,990
Alabama	375,754	5,335,707	2,721,211
Mississippi	145,141	2,249,686	1,057,352
Louisiana	34,188	547,008	240,684

Area, product, and value of oats, 1893—Continued.

States and Territories.	Acres.	Bushels.	Value.
Texas	588, 483	14, 770, 923	$6, 203, 788
Arkansas	311, 336	6, 008, 785	2, 343, 426
Tennessee	530, 914	9, 768, 818	3, 028, 334
West Virginia	159, 113	3, 739, 156	1, 420, 879
Kentucky	584, 626	12, 978, 697	4, 412, 757
Ohio	952, 300	27, 235, 780	8, 170, 734
Michigan	891, 428	23, 177, 128	7, 416, 681
Indiana	1, 166, 988	32, 092, 170	8, 985, 808
Illinois	3, 082, 433	83, 842, 178	22, 637, 388
Wisconsin	1, 691, 314	46, 680, 266	12, 603, 672
Minnesota	1, 675, 895	41, 562, 196	10, 806, 171
Iowa	3, 848, 719	95, 448, 231	21, 953, 093
Missouri	1, 240, 779	29, 034, 229	7, 258, 557
Kansas	1, 578, 119	29, 195, 202	7, 882, 705
Nebraska	1, 599, 239	23, 988, 585	5, 277, 489
South Dakota	765, 582	16, 460, 013	4, 115, 003
North Dakota	490, 963	10, 752, 090	3, 010, 585
Montana	66, 986	2, 277, 524	842, 684
Wyoming	16, 677	400, 248	160, 099
Colorado	104, 740	2, 796, 558	1, 034, 726
New Mexico	11, 215	327, 473	167, 014
Arizona	....	....	....
Utah	28, 307	789, 765	260, 622
Nevada	....	....	....
Idaho	22, 171	733, 860	200, 883
Washington	86, 745	3, 443, 777	1, 205, 322
Oregon	232, 455	6, 624, 963	2, 451, 238
California	59, 011	1, 504, 781	571, 817
Total	27, 273, 033	638, 854, 850	187, 576, 092

The following table exhibits the total production, area, and value of the oat crops from 1880 to 1893, inclusive; also the average value per bushel in each of the years presented; the average yield and value per acre, together with the average for the ten year periods 1870 to 1879, inclusive, 1880 to 1889, inclusive, and the four-year term 1890 to 1893, inclusive:

Oat crops of the fourteen years, 1880–1893, with averages for two decades.

Years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1880	417, 885, 380	16, 187, 977	$150, 243, 565	36	25·8	$9. 28
1881	416, 481, 000	16, 831, 600	193, 198, 970	46·4	24·7	11. 48
1882	488, 250, 610	18, 494, 691	182, 978, 022	37·5	26·4	9. 89
1883	571, 302, 400	20, 324, 962	187, 040, 264	32·7	28·1	9. 20
1884	583, 628, 000	21, 300, 917	161, 528, 470	27·7	27·4	7. 58
1885	629, 409, 000	22, 783, 630	179, 631, 860	28·5	27·6	7. 88
1886	624, 134, 000	23, 658, 474	186, 137, 930	29·8	26·4	7. 87
1887	659, 618, 000	25, 920, 906	200, 699, 790	30·4	25·4	7. 74
1888	701, 735, 000	26, 998, 282	195, 424, 240	27·8	26	7. 24
1889	751, 515, 000	27, 462, 316	171, 781, 008	22·9	27·4	6. 26
Total	5, 843, 958, 390	219, 963, 755	1, 808, 664, 119	....	....	....
Average for 10 years—1880 to 1889	584, 395, 839	21, 996, 376	180, 866, 412	30·9	26·6	8. 22
Average for 10 years—1870 to 1879	314, 441, 178	11, 076, 822	111, 075, 223	35·3	28·4	10. 03
1890	523, 621, 000	26, 431, 369	222, 048, 486	42·4	19·8	8. 40
1891	738, 394, 000	25, 581, 861	232, 312, 267	31·5	28·9	9. 08
1892	661, 035, 000	27, 063, 835	209, 253, 611	31·7	24·4	7. 73
1893	638, 854, 850	27, 273, 033	187, 576, 092	29·4	23·4	6. 88
Total	2, 561, 904, 850	106, 350, 098	851, 190, 456	....	....	....
Average for 4 years—1890 to 1893	640, 476, 213	26, 587, 525	212, 797, 614	33·2	24·1	8. 00

RYE.

Since the year 1888 the Statistician of the Department has made no estimates of the minor crops, such as rye, barley, and buckwheat, nor of such important crops as potatoes, hay, tobacco, and cotton.

The last estimate was made of these crops in 1888, and showed the area devoted to rye that year to be 2,364,805 acres, producing a total of 28,415,000 bushels.

The following table shows the area, product, and farm value by States of the crop for the year 1893:

Area, product, and value of rye, 1893.

States and Territories.	Acres.	Bushels.	Value.
Maine	1,045	12,540	$13,543
New Hampshire	1,003	15,145	11,813
Vermont	3,144	44,016	32,132
Massachusetts	10,140	164,268	123,201
Connecticut	16,098	255,958	168,932
New York	229,838	3,424,586	2,157,489
New Jersey	76,473	1,024,738	717,317
Pennsylvania	316,147	4,647,361	2,648,996
Maryland	29,732	389,489	198,639
Virginia	46,076	428,507	259,964
North Carolina	55,908	430,492	301,344
South Carolina	4,378	23,641	26,005
Georgia	20,499	131,194	141,690
Alabama	2,145	21,021	24,174
Texas	5,330	49,569	33,707
Arkansas	2,318	17,385	10,083
Tennessee	21,470	203,965	120,339
West Virginia	14,956	122,639	79,715
Kentucky	37,866	499,831	289,902
Ohio	63,189	960,473	451,422
Michigan	127,013	1,625,766	715,337
Indiana	54,675	787,320	354,294
Illinois	126,597	1,759,698	721,476
Wisconsin	272,198	3,946,871	1,697,155
Minnesota	67,054	1,025,926	420,630
Iowa	81,078	1,183,739	485,333
Missouri	18,636	238,541	107,343
Kansas	177,911	1,245,377	473,243
Nebraska	98,183	991,648	347,077
South Dakota	7,892	83,655	30,952
North Dakota	1,903	23,407	7,490
Colorado	5,683	119,343	59,672
Utah	3,594	42,769	20,101
Washington	2,322	35,062	24,193
Oregon	7,191	75,506	55,119
California	28,800	504,000	302,400
Total	2,038,485	26,555,446	13,612,222

BARLEY.

As already stated, barley is one of the crops of which no estimate has been made since 1888. The average area for the eight years 1881 to 1888, inclusive, is 2,563,511 acres. The area of 1893 shows an increase of 223,689 acres over that of 1888 and 656,560 acres over the average area for the period above named. The average annual product for the eight years was 54,992,294 bushels. The product of 1893 exceeds this average by nearly 15,000,000 bushels. The average yield per acre has not varied much. The annual average for the ten years 1870–1879 was 22 bushels per acre; for the nine years 1880–1888, inclusive, it was 21·7, and for the year 1893, 21·7. The census of 1889 makes the area of barley for that year 3,220,795 acres, and the product 78,331,492 bushels, or 24·3 bushels per acre. The following table shows acreage, product, and value by States:

Area, product, and value of barley, 1893.

States and Territories.	Acres.	Bushels.	Value.
Maine	14, 184	370, 202	$248, 035
New Hampshire	5, 081	128, 549	89, 984
Vermont	17, 945	493, 488	296, 093
Massachusetts	1, 821	46, 071	41, 464
Rhode Island	370	9, 324	8, 112
New York	270, 612	5, 493, 424	3, 296, 054
Pennsylvania	18, 529	352, 051	176, 026
Texas	2, 757	39, 977	24, 786
Tennessee	2, 946	44, 485	24, 467
Kentucky	4, 763	80, 971	41, 295
Ohio	34, 955	793, 479	372, 935
Michigan	83, 193	1, 315, 264	644, 479
Indiana	7, 420	147, 658	66, 446
Illinois	30, 978	718, 690	287, 476
Wisconsin	459, 366	11, 024, 784	4, 740, 657
Minnesota	419, 367	9, 268, 011	3, 336, 484
Iowa	513, 233	11, 599, 066	3, 827, 692
Missouri	1, 633	32, 660	13, 064
Kansas	15, 847	128, 361	60, 330
Nebraska	76, 690	920, 280	285, 287
South Dakota	155, 015	2, 387, 231	787, 786
North Dakota	186, 964	2, 841, 853	880, 974
Montana	5, 183	156, 008	78, 004
Colorado	12, 944	366, 315	183, 158
New Mexico	1, 543	33, 329	19, 331
Arizona	11, 073	298, 971	155, 465
Utah	6, 303	236, 993	106, 647
Nevada	7, 869	280, 923	168, 554
Idaho	10, 297	308, 910	163, 722
Washington	46, 408	1, 360, 961	725, 775
Oregon	37, 369	975, 096	390, 038
California	760, 716	17, 116, 110	7, 188. 766
Total	3, 220, 371	69, 869, 495	28, 729, 386

BUCKWHEAT.

The last estimate on buckwheat made by the Department was in 1888, when the area was placed at 912,630 acres and the product at 12,050,000 bushels. The census of 1889 gave the area at 837,200 acres and the product 12,113,040 bushels. The Department estimate for the year 1893 is: Area, 815,614 acres; product, 12,132,311 bushels. The following table exhibits the acreage, product, and value by States:

Area, product, and value of buckwheat, 1893.

States and Territories.	Acres.	Bushels.	Value.
Maine	23, 314	676, 106	$365, 097
New Hampshire	3, 055	70, 876	26, 224
Vermont	12, 487	364, 620	193, 249
Massachusetts	2, 473	68, 008	51, 006
Connecticut	4, 164	65, 791	47, 370
New York	285, 488	4, 111, 027	2, 466, 616
New Jersey	13, 647	196, 517	129, 701
Pennsylvania	218, 580	3, 081, 978	1, 818, 367
Delaware	325	6, 500	3, 575
Maryland	7, 344	86, 659	50, 262
Virginia	5, 166	68, 708	37, 789
North Carolina	1, 670	19, 205	9, 410
Tennessee	1, 409	17, 753	9, 587
West Virginia	13, 692	157, 458	107, 071
Ohio	13, 841	166, 092	99, 655
Michigan	59, 396	825, 604	437, 570
Indiana	7, 263	50, 115	28, 064
Illinois	6, 555	76, 038	43, 342
Wisconsin	64, 327	1, 016, 367	579, 329
Minnesota	23, 206	352, 731	186, 947
Iowa	25, 016	330, 211	201, 429
Missouri	2, 689	34, 150	19, 807
Kansas	3, 675	35, 648	25, 310
Nebraska	14, 435	212, 195	110, 341
South Dakota	1, 305	19, 836	12, 893
North Dakota	138	2, 001	1, 261
Oregon	263	5, 260	2, 630
California	691	4, 857	10, 548
Total	815, 614	12, 132, 311	7, 074, 450

TOBACCO.

The last estimates made by this office of the acreage, production, and value of tobacco, prior to those given below, appeared in the Annual Report of the Department for 1889, being the figures of the crop for 1888. The area as estimated for that year was 747,326 acres, producing 565,795,000 pounds of tobacco, of a total value of $43,666,665. The crop of the following year, 1889, was returned by the U. S. Census at 488,255,896 pounds, the product of 692,990 acres, with a total value of $34,844,449. The present estimates place the crop of 1893 at 483,023,963 pounds, the area at 702,952 acres, and the total value of the product at $39,155,442. It would seem from a comparison of the estimates of 1888 with the census figures that the former were considerably too high, very decided declines in acreage in several States between the censuses of 1879 and 1889 not being duly reflected. These discrepancies have been eliminated in the present estimates. The acreage for the whole country differs but little from that of 1889, the increase over the census figures being less than 8,000 acres. The yield, on the contrary, was over two per cent lower, and the total production was over 5,000,000 pounds less than for the census year, despite the increased acreage.

Area, product, and value of tobacco, 1893.

States.	Acres.	Pounds.	Value.
Massachusetts	2, 640	4, 356, 000	$696, 960
Connecticut	7, 459	10, 658, 911	1, 492, 248
New York	8, 133	7, 360, 365	1, 118, 775
Pennsylvania	27, 715	27, 715, 000	3, 741, 525
Maryland	15, 233	10, 343, 207	786, 084
Virginia	103, 003	68, 599, 998	4, 253, 200
North Carolina	88, 208	44, 897, 872	3, 591, 830
Arkansas	1, 932	1, 707, 888	170, 789
Tennessee	48, 518	30, 905, 966	2, 719, 725
West Virginia	4, 503	3, 417, 777	348, 613
Kentucky	307, 697	216, 926, 385	16, 486, 405
Ohio	41, 659	18, 246, 642	1, 186, 032
Indiana	6, 348	4, 532, 472	330, 870
Illinois	3, 870	2, 109, 150	147, 641
Wisconsin	25, 091	22, 305, 899	1, 405, 272
Missouri	10, 943	8, 940, 431	679, 473
Total	702, 952	483, 023, 963	39, 155, 442

POTATOES.

The annual average yield per acre of potatoes for the ten years preceding 1880 was 87·7 bushels, and for the nine years, 1880 to 1888, inclusive, 76·3 bushels. The estimates of 1893 make the crop area 2,605,186 acres, and the product 183,034,203 bushels, a yield of 70·3 bushels per acre, which is 17·4 bushels less than for the ten years 1870 to 1879, and 6 bushels below the later period of nine years, 1880 to 1888, inclusive. The crop of 1888 showed a yield per acre of a little less than 80 bushels. The following table exhibits acreage, product, and value by States:

Area, product, and value of potatoes, 1893.

States and Territories.	Acres.	Bushels.	Value.
Maine	51, 905	6, 228, 600	$3, 363, 444
New Hampshire	21, 840	2, 598, 960	1, 637, 345
Vermont	29, 471	3, 271, 281	1, 570, 215
Massachusetts	29, 349	3, 492, 531	2, 654, 324
Rhode Island	6, 172	666, 576	526, 595
Connecticut	24, 310	2, 114, 970	1, 586, 228
New York	357, 291	25, 010, 370	13, 755, 704
New Jersey	49, 064	3, 581, 672	2, 686, 254
Pennsylvania	198, 922	15, 118, 072	9, 070, 843
Delaware	4, 521	226, 050	146, 933
Maryland	25, 421	1, 245, 629	847, 028
Virginia	38, 392	3, 224, 928	1, 838, 209
North Carolina	18, 321	1, 777, 137	1, 066, 282
South Carolina	4, 208	349, 264	268, 933
Georgia	6, 539	483, 886	445, 175
Florida	1, 422	123, 714	144, 745
Alabama	6, 159	511, 197	449, 853
Mississippi	5, 852	474, 012	398, 170
Louisiana	9, 589	642, 463	533, 244
Texas	13, 516	716, 348	737, 838
Arkansas	16, 572	1, 458, 336	933, 335
Tennessee	40, 161	2, 730, 948	1, 338, 165
West Virginia	30, 787	2, 462, 960	1, 453, 146
Kentucky	46, 840	3, 185, 120	1, 783, 667
Ohio	177, 576	10, 299, 408	6, 900, 603
Michigan	195, 700	14, 677, 500	6, 604, 875
Indiana	101, 501	5, 176, 551	3, 778, 882
Illinois	160, 461	8, 504, 433	6, 293, 280
Wisconsin	156, 988	12, 088, 076	5, 923, 157
Minnesota	114, 167	7, 535, 022	3, 466, 110
Iowa	168, 195	9, 755, 310	6, 340, 952
Missouri	90, 443	7, 054, 554	4, 021, 096
Kansas	106, 091	4, 668, 004	3, 687, 723
Nebraska	112, 853	4, 965, 532	3, 922, 770
South Dakota	44, 045	2, 378, 430	1, 403, 274
North Dakota	19, 550	1, 348, 950	660, 986
Montana	4, 799	662, 262	456, 961
Wyoming	2, 043	273, 762	177, 945
Colorado	33, 696	3, 167, 424	1, 710, 409
New Mexico	618	43, 260	28, 984
Arizona	391	29, 325	17, 595
Utah	5, 893	518, 584	171, 133
Nevada	1, 352	178, 464	71, 386
Idaho	3, 812	583, 236	326, 612
Washington	14, 413	1, 729, 560	674, 528
Oregon	16, 772	2, 130, 044	1, 001, 121
California	37, 203	3, 571, 488	1, 785, 744
Total	2, 605, 186	183, 034, 203	108, 661, 801

HAY.

The estimates for hay place the acreage at 49,613,469 acres, from which were harvested 65,766,158 tons, valued at $570,882,872. This is an increase in acreage over the estimates of 1888 of 11,021,566 acres, which is made up mostly in States beyond the Mississippi. The increase in product was something over 19,000,000 tons, the increase in aggregate value being $161,383,307. The difference between the acreage of 1888 and that of 1893, if the figures be accepted as correct, would show a greater increase than can reasonably be accounted for in view of the conditions surrounding agricultural growth in the last five years. It must, therefore, be accounted for by the supposition that the figures of 1888 were greatly below the actual acreage at that date.*

* Since this paragraph was written the figures of the last census, though not yet published, have been obtained from the Census Office, and show the area mown in 1889 to have been 52,948,797 acres, and the product obtained to have been 66,831,480 tons.

Area, product, and value of hay, 1893.

States and Territories.	Acres.	Tons.	Value.
Maine	1,227,702	1,129,486	$13,700,665
New Hampshire	634,487	672,556	10,491,874
Vermont	926,659	1,028,591	10,933,922
Massachusetts	630,048	724,555	12,556,538
Rhode Island	86,543	71,831	1,407,888
Connecticut	517,699	512,522	8,969,135
New York	5,885,652	7,298,208	82,688,697
New Jersey	532,162	526,840	9,182,821
Pennsylvania	3,085,850	3,178,426	45,769,334
Delaware	57,499	43,124	733,108
Maryland	406,567	422,830	6,025,328
Virginia	769,347	853,975	11,178,533
North Carolina	182,805	310,769	3,452,644
South Carolina	162,468	255,075	2,466,575
Georgia	162,210	214,117	2,582,251
Florida	7,813	15,626	308,614
Alabama	75,055	114,084	1,282,304
Mississippi	82,113	135,486	1,302,020
Louisiana	36,901	59,780	538,020
Texas	452,687	470,794	4,519,622
Arkansas	200,070	234,082	2,193,348
Tennessee	551,278	766,276	8,245,130
West Virginia	620,750	682,825	8,706,019
Kentucky	663,566	832,543	8,966,637
Ohio	2,486,295	3,306,772	33,233,059
Michigan	1,280,305	1,869,245	17,122,284
Indiana	2,114,391	2,875,572	26,340,240
Illinois	2,705,681	3,273,874	29,006,524
Wisconsin	1,518,986	2,308,859	16,623,785
Minnesota	1,723,273	2,791,702	12,758,078
Iowa	5,457,335	8,622,589	53,115,148
Missouri	2,944,553	3,651,246	25,704,772
Kansas	3,339,282	4,374,459	20,516,213
Nebraska	2,071,730	2,589,663	12,611,659
South Dakota	971,825	1,379,992	5,064,571
North Dakota	429,280	553,771	2,060,028
Montana	349,659	440,570	3,476,097
Wyoming	220,358	297,483	2,379,864
Colorado	794,752	945,755	6,601,370
New Mexico	39,846	82,880	704,480
Arizona	36,219	63,383	522,910
Utah	177,797	305,811	1,581,043
Nevada	135,931	361,576	3,615,760
Idaho	211,561	518,324	2,850,782
Washington	358,612	566,607	5,195,786
Oregon	605,946	1,139,178	9,227,342
California	1,681,921	2,842,446	22,370,050
Total	49,613,469	65,766,158	570,882,872

FARM PRICES AND MARKET QUOTATIONS.

In connection with the table giving the average farm prices of the principal agricultural products as finally determined for December 1, 1893, a statement has been prepared showing wholesale prices of these products at leading cities in all sections of the United States for the four months August to November, 1893, as compared with 1892. These quotations have been obtained from the publications of the boards of trade and similar bodies in the respective cities, and it is proposed to publish similar statements from time to time in the monthly reports of the Statistician.

Table showing final estimates of the average farm prices of various agricultural products, December 1, 1893, together with the acreage sown to winter wheat as compared with the area harvested in 1893, and the average condition of winter wheat and winter rye.

States and Territories.	Corn, per bushel.	Wheat, per bushel.	Rye, per bushel.	Oats, per bushel.	Barley, per bushel.	Buckwheat, per bushel.	Potatoes, Irish, per bushel.	Hay, per ton.	Cotton, per pound.	Leaf tobacco, per pound.	Winter wheat. Area sown, compared with area harvested in 1893.	Winter wheat. Average condition December 1.	Winter rye, average condition December 1.
									Cents.	*Cents.*			
Maine	$0.62	$1.02	$1.08	$0.45	$0.67	$0.54	$0.54	$12.13	......	......	......	......	......
New Hampshire	.57	.85	.78	.43	.70	.37	.63	15.60	......	......	100	......	......
Vermont	.61	.85	.73	.42	.60	.53	.48	10.63	......	......	94	......	......
Massachusetts	.62	......	.75	.42	.90	.75	.76	17.33	......	16	......	......	......
Rhode Island	.69	......	.79	.43	.87	1.00	.79	19.60	......	......	......	......	......
Connecticut	.64	......	.66	.40	......	.72	.75	17.50	......	14	100	......	101
New York	.55	.76	.63	.30	.60	.60	.55	11.33	......	15.2	88	99	95
New Jersey	.52	.70	.70	.35	......	.66	.75	17.43	......	......	92	99	102
Pennsylvania	.49	.65	.57	.35	.50	.59	.60	14.40	......	13.5	98	97	93
Delaware	.40	.60	.50	.38	......	.55	.65	17.00	......	......	105	98	100
Maryland	.44	.76	.51	.35	.55	.58	.68	14.25	......	7.6	91	96	98
Virginia	.46	.63	.56	.35	.48	.55	.57	13.00	7.1	6.2	95	94	102
North Carolina	.50	.72	.70	.44	.52	.49	.60	11.11	7.2	8	102	98	100
South Carolina	.60	.98	1.10	.53	1.15	......	.77	9.67	7.1	......	101	95	97
Georgia	.56	.90	1.08	.52	1.15	......	.92	12.06	7.3	......	100	95	100
Florida	.68	......	1.10	.55	......	......	1.17	19.75	7.3	......	......	......	......
Alabama	.59	.88	1.15	.51	......	......	.88	11.24	7	......	116	96	101
Mississippi	.55	.85	.88	.47	......	......	.84	9.61	7.	......	74	94	102
Louisiana	.57	......	......	.44	......	......	.83	9.00	7.	......	......	......	......
Texas	.54	.58	.68	.42	.62	......	1.03	9.60	6.9	......	86	75	81
Arkansas	.45	.65	.58	.39	......	......	.64	9.37	6.8	10.	92	85	94
Tennessee	.39	.57	.59	.31	.55	.54	.49	10.76	6.5	8.8	96	95	101
West Virginia	.55	.72	.65	.38	......	.68	.59	12.75	......	10.2	99	93	102
Kentucky	.43	.57	.58	.34	.51	......	.53	10.16	......	7.6	92	97	95
Ohio	.40	.57	.47	.30	.47	.60	.67	10.65	......	6.5	91	92	93
Michigan	.45	.57	.44	.32	.49	.53	.45	9.16	......	......	79	89	90
Indiana	.36	.53	.45	.28	.45	.56	.73	9.16	......	7.3	93	90	98
Illinois	.31	.51	.41	.27	.40	.57	.74	8.86	......	7.	91	88	91
Wisconsin	.35	.54	.43	.27	.43	.57	.49	7.20	......	6.3	85	86	......
Minnesota	.34	.51	.41	.26	.36	.53	.46	4.57	......	......	115	94	......
Iowa	.27	.49	.41	.23	.33	.61	.65	6.16	......	......	98	90	......
Missouri	.30	.48	.45	.25	.40	.58	.57	7.04	......	7.6	82	82	......
Kansas	.31	.42	.38	.27	.47	.71	.79	4.69	......	......	95	89	......
Nebraska	.27	.40	.35	.22	.31	.52	.79	4.87	......	......	115	82	96
South Dakota	.25	.44	.37	.25	.33	.65	.59	3.67	......	......	......	......	91
North Dakota	.38	.43	.32	.28	.31	.63	.49	3.72	......	......	......	......	......
Montana	.70	.60	.47	.37	.50	......	.69	7.89	......	......	100	......	......
Wyoming	.63	.65	.77	.40	.73	......	.65	8.00	......	......	......	......	......
Colorado	.51	.52	.50	.37	.50	......	.54	6.98	......	......	105	98	......
New Mexico	.71	.75	.68	.51	.58	......	.67	8.50	......	......	115	......	......
Arizona	.66	.65	......	......	.52	......	.60	8.25	......	......	100	......	......
Utah	.58	.60	.47	.33	.45	......	.33	5.17	......	......	96	95	......
Nevada	......	.73	......	......	.60	......	.40	10.00	......	......	100	......	......
Idaho	.71	.60	.50	.41	.53	......	.56	5.50	......	......	100	......	......
Washington	.62	.48	.69	.35	.39	.80	.39	9.17	......	......	90	95	......
Oregon	.47	.55	.73	.37	.40	.50	.47	8.10	......	......	101	99	......
California	.50	.53	.60	.38	.42	.71	.50	7.87	......	......	102	100	108
General average	.365	.538	.513	.294	.411	.583	.59	8.68	6.99	8.1	93.2	91.5	94.6

DISTRIBUTION AND CONSUMPTION OF CORN AND WHEAT.

CORN.

The tendency to an enlargement of the area devoted to corn, as noted in a former report, does not seem to be sustained by the experience of the past two years. The aggregate area for the five-year period from 1884 to 1888, inclusive, was 366,573,621 acres, giving an average of 73,314,724 acres. For the succeeding quinquennium the total area was

369,158,052 acres, making an average for this period of 73,831,610 acres. In 1892 the area was 70,626,658, or 2,688,066 acres less than the average for the first of these five-year periods and 3,204,952 acres less than the average for the last, while the area of 1893, although an increase of about 1,410,000 acres over that of the preceding year, was still under the averages of the periods named by 1,278,259 and 1,795,145 acres, respectively. The crop of 1893, notwithstanding the increase over the area of 1892, was some 9,000,000 bushels less, or 1,619 millions against 1,628 millions. The apparent consumption, however, up to March 1, 1894, was greater than for the corresponding period of the year before, being 1,033,000,000 as against 1,002,000,000 bushels. The exports of corn for the fiscal year ending June 30, 1893, were 47,121,894 bushels, and for the seven months ending January 31, 1894, 38,413,309 bushels, which is within about 8,700,000 bushels of the total exports during the last fiscal year.

The following table shows exports of corn (including meal) from 1884 to 1893—fiscal years—and for the seven months ending January 31, 1894:

Exports of corn (including meal) from 1884 to January 31, 1894.

Years ending June 30—	Bushels.	Years ending June 30—	Bushels.
1884	46, 258, 606	1890	103, 418, 709
1885	52, 876, 456	1891	32, 041, 529
1886	64, 829, 617	1892	76, 602, 285
1887	41, 368, 584	1893	47, 121, 894
1888	25, 360, 869	From July 1, 1893, to Jan. 31, 1894, or seven months	38, 413, 309
1889	70, 841, 673		

The corn in producers' hands, as estimated, aggregates 586,000,000 bushels, or 36·2 per cent of the last crop. This proportion is less than for any year in the past five, except 1891.

The following statement is a comparison of the distribution for each of the past ten years:

Comparative distribution of corn for the ten years 1884–1893.

	Product of previous year.	On hand March 1.	Per cent.	Consumed or distributed.
	Bushels.	*Bushels.*		*Bushels.*
March, 1885	1, 795, 000, 000	675, 000, 000	37·6	1, 120, 000, 000
1886	1, 936, 000, 000	773, 000, 000	39·9	1, 163, 000, 000
1887	1, 665, 000, 000	603, 000, 000	36·2	1, 062, 000, 000
1888	1, 456, 000, 000	508, 000, 000	34·9	948, 000, 000
1889	1, 988, 000, 000	787, 000, 000	39·6	1, 201, 000, 000
1890	2, 113, 000, 000	970, 000, 000	45·9	1, 143, 000, 000
1891	1, 490, 000, 000	542, 000, 000	36·4	948, 000, 000
1892	2, 060, 000, 000	860, 000, 000	41·8	1, 200, 000, 000
1893	1, 628, 000, 000	627, 000, 000	38·5	1, 002, 000, 000
1894	1, 619, 000, 000	586, 000, 000	36·2	1, 033, 000, 000

The following table exhibits the proportion of the crop consumed or distributed by March 1 for the ten years from 1885 to 1894, inclusive. As usual, the proportion distributed in the southern section of the country is less than in any other, being 60 per cent. In the western section the amount is somewhat larger than last year, while for the whole country it is 2·3 per cent larger. The proportions as indicated are as follows:

Proportion of corn crop consumed by March 1 of the years 1885–1894.

Sections.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
New England	62·9	61·6	63·3	65·4	66·5	66·4	67·7	63·8	64	67·7
Middle	63·4	59·3	61·8	65·6	62	59.9	62·3	58·2	64·1	65·8
Southern	58·6	51·6	58·1	55·5	55·7	53.5	56	54·1	55·3	60
Western	63·3	61·6	65·7	69·3	61·5	53.8	66·3	59·3	63·2	64·8
Mountain region..	68·1	64·5	66·7	72	72·5	75·1	74·5	65·5	66·9	63·9
Pacific	60·7	68·6	70·5	78·2	75·1	71·4	73·5	69·7	70·6	72·9
Average	62·4	60·1	63·8	65·1	60·4	54·1	63·6	58·2	61·5	63·8

The account of stores still in the possession of original producers shows an aggregate of nearly 586,000,000 bushels, or 36·2 per cent of the product of last year (1893). Of this amount nearly 72 per cent is to be found in the Western group, which includes the chief of the surplus States.

The amount and proportion on hand on March 1, out of each of the crops of the four years 1890–1893 are as follows:

Sections.	1891.		1892.		1893.		1894.	
	Bushels.	*Per ct.*	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*
New England	2,709,930	32·3	3,362,910	36·2	2,319,400	36	1,757,660	32·3
Middle	26,566,520	37·7	36,007,800	41·8	25,111,090	35·9	20,001,890	34·2
Southern	164,036,740	44	199,486,710	45·9	161,678,910	44·7	141,383,250	40
Western	346,977,230	33·7	618,851,680	40·7	435,731,850	36·8	420,841,450	35·2
Mountain region ..	669,960	25·5	916,240	34·5	1,220,000	33·1	1,080,630	36·1
Pacific	1,212,870	26·5	1,768,610	30·3	786,120	29·4	751,470	27·1
Total	542,173,250	36.4	860,393,950	41·8	626,847,370	38·5	585,816,350	36·2

It is conceded that ordinarily only the seven Western States of Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, and Nebraska have any material excess over what is required for home consumption, and it is from these States, therefore, that the great commercial supplies are drawn. In these States there was on hand on March 1 an aggregate of 360,000,000 bushels, in round numbers, against 380,000,000 bushels last year and 546,000,000 bushels the year before. The present supply is greater than last year's in only two of the seven States, viz, Iowa and Missouri. The largest proportion is in Iowa—42 per cent—with Missouri and Nebraska coming next, each showing 36 per cent of their respective crops.

States.	1891.		1892.		1893.		1894.	
	Bushels.	*Per ct.*	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*
Ohio	19,104,040	29	37,636,800	40	29,348,550	35	22,570,450	35
Indiana	24,927,000	28	49,448,800	40	36,166,900	35	27,318,080	32
Illinois	63,731,640	34	100,998,400	43	61,170,990	37	56,192,500	35
Iowa	86,002,430	37	164,912,660	47	84,092,820	42	105,769,440	42
Missouri	63,124,200	36	69,091,400	34	51,846,260	34	56,951,280	36
Kansas	15,475,320	28	45,405,760	32	48,122,250	33	34,864,250	25
Nebraska	17,699,200	32	78,796,440	47	69,143,800	44	56,620,440	36
Total	290,063,830	33·7	546,290,260	41·5	379,891,570	37·7	360,286,440	35·4

The crop of corn last year (1893), together with the stock on hand on the 1st of March, 1894, and the proportion of the whole crop consumed in or shipped out of the county, where grown, is presented by States

below. While the table shows that these portions vary more or less in the different States, the familiar fact that the bulk of our corn is consumed in the vicinity where grown is clearly shown by the following table:

Disposal of corn crop of 1893.

States and Territories.	Crop of 1893.	Stock on hand Mar. 1, 1894.		Consumed in county where grown.		Shipped out of county where grown.	
	Bushels.	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
Maine	411, 000	115, 080	28	390, 450	95	20, 550	5
New Hampshire	795. 000	230, 550	29	795, 000	100		
Vermont	1, 429, 000	500, 150	35	1, 429, 000	100		
Massachusetts	1. 355, 000	352, 300	26	1, 355, 000	100		
Rhode Island	218, 000	80, 660	37	202, 740	93	15, 260	7
Connecticut	1, 228, 000	478, 920	39	1. 228. 000	100		
New York	15, 255, 000	5, 491. 800	36	15, 102, 450	99	152, 550	1
New Jersey	7, 179, 000	2, 871, 600	40	6. 748, 260	94	430, 740	6
Pennsylvania	31, 199, 000	9, 671, 690	31	29, 639, 050	95	1, 559, 950	5
Delaware	4, 917. 000	1, 966, 800	40	1, 229, 250	25	3, 687, 750	75
Maryland	15, 078, 000	4, 674, 180	31	12, 363, 960	82	2, 714, 040	18
Virginia	31, 234, 000	13, 430, 620	43	27, 173. 580	87	4, 060. 420	13
North Carolina	29, 954, 000	13, 479, 300	45	27, 857, 220	93	2, 096, 780	7
South Carolina	12, 501, 000	4. 875, 390	39	12, 250, 980	98	250, 020	2
Georgia	33, 678, 000	15, 155, 100	45	32, 330, 880	96	1, 347, 120	4
Florida	4, 909, 000	2, 012, 690	41	4, 909, 000	100		
Alabama	28, 329, 000	13, 031, 340	46	27, 479, 130	97	849, 870	3
Mississippi	25, 817, 000	12, 650, 330	49	25, 817, 000	100		
Louisiana	15, 216, 000	6, 999, 360	46	15. 216, 000	100		
Texas	61, 171, 000	17, 739, 590	29	56, 889, 030	93	4, 281, 970	7
Arkansas	32, 111, 000	11, 238, 850	35	31, 147, 670	97	963. 330	3
Tennessee	63, 650. 000	26, 096, 500	41	54, 739, 000	86	8, 911, 000	14
West Virginia	14, 098, 000	4, 508, 480	32	13, 525, 440	96	563, 560	4
Kentucky	68, 008, 000	26, 523, 120	39	63, 247, 440	93	4, 760, 560	7
Ohio	64, 487, 000	22, 570, 450	35	52, 879, 340	82	11, 607, 660	18
Michigan	21, 791, 000	4, 794, 020	22	21, 355, 180	98	435, 820	2
Indiana	85, 369, 000	27, 318, 080	32	75, 124, 720	88	10, 244, 280	12
Illinois	160, 550, 000	56, 192, 500	35	117, 201, 500	73	43, 348, 500	27
Wisconsin	28, 956, 000	9, 265, 920	32	28, 087, 320	97	868, 680	3
Minnesota	25, 104, 000	8, 033, 280	32	22, 844, 640	91	2, 259, 360	9
Iowa	251, 832, 000	105, 769, 440	42	193, 910, 640	77	57, 921, 360	23
Missouri	158, 198, 000	56, 951, 280	36	136, 050, 280	86	22, 147, 720	14
Kansas	139, 457, 000	34, 864, 250	25	124, 116, 730	89	15, 340, 270	11
Nebraska	157, 279, 000	56, 620, 440	36	110, 095. 300	70	47, 183, 700	30
South Dakota	20, 512, 000	7, 384, 320	36	18, 871, 040	92	1, 640, 960	8
North Dakota	417, 000	45, 870	11	417, 000	100		
Montana	30, 000	4, 500	15	30, 000	100		
Wyoming	38, 000			38, 000	100		
Colorado	2, 031, 000	792, 090	39	2, 010, 690	99	20, 310	1
New Mexico	636, 000	222, 600	35	610, 560	96	25, 440	4
Arizona	82, 000	16, 400	20	75, 440	92	6, 560	8
Utah	184, 000	38, 640	21	180, 320	98	3, 680	2
Nevada							
Idaho	32, 000	6, 400	20	32, 000	100		
Washington	179, 000	26, 850	15	179. 000	100		
Oregon	324, 000	42, 120	13	324, 000	100		
California	2, 275, 000	682, 500	30	1, 660, 750	73	614, 250	27
Total	1, 619, 494, 000	585, 816, 350	36·2	1, 369, 159, 980	84·5	250, 334, 020	15·5

The following table indicates that only 15·5 per cent of the crop of last year has been moved beyond county lines, i. e., for the country at large. In the western section the proportion entering commercial channels is, of course, higher, being a little over 18 per cent of the crop raised in that division. This is also true of the Pacific region, where 22 per cent of a crop of a little over 2,000,000 bushels was distributed beyond county lines. In the New England, Middle, Southern, and Mountain region divisions the crop is almost entirely consumed where grown. The statement is for the years 1893 and 1894:

Sections.	1893.				1894.			
	Retained for county consumption.		Distribution beyond county lines.		Retained for county consumption.		Distribution beyond county lines.	
	Bushels.	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
New England	6,423,720	99·7	21,280	·3	5,400,190	99·3	35,810	·7
Middle	64,291,150	91·9	5,653,850	8·1	52,719,010	90	5,830,990	10
Southern	328,236,200	90·8	33,326,800	9·2	328,173,450	92·8	25,474,550	7·2
Western	946,535,660	79·9	237,623,340	20·1	977,726,570	81·7	218,322,430	18·2
Mountain region	3,497,890	95	184,110	5	2,977,010	98·2	55,990	1·8
Pacific	2,099,980	78·7	570,020	21·3	2,163,750	77·9	614,250	22·1
Total	1,351,084,600	83	277,379,400	17	1,369,159,980	84·5	250,334,020	15·5

Quality as well as quantity is a matter of importance in estimating the value of a crop. The result of investigations covering the quality is given in the following table. The proportion of merchantable corn is 85·6 per cent of the whole crop, and represents in quantity over 1,386,000,000 bushels against 1,345,000,000 bushels of the larger crop of 1892. The proportion was some 3 per cent less than that of the crop of 1891, the latter being 88·5 per cent. The injury to quality from drought and frost was not so great as was believed at the close of the season. The proportions since 1885 are as follows:

Year.	Merchantable.		Unmerchantable.	
	Bushels.	*Per cent.*	*Bushels.*	*Per cent.*
1885	1,583,012,860	78·	353,163,140	22·
1886	1,438,446,830	86·	226,994,170	14·
1887	1,222,166,360	84·	233,994,640	16·
1888	1,637,405,930	82·4	350,384,070	17·6
1889	1,810,557,850	85·7	302,334,150	14·3
1890	1,183,794,720	79·5	306,175,280	20·5
1891	1,822,430,570	88·5	237,223,430	11·5
1892	1,345,444,720	82·6	283,019,280	17·4
1893	1,386,356,820	85·6	233,137,180	14·4

The following table exhibits, by States and Territories, the proportions of merchantable and unmerchantable corn, the price per bushel, and the value of the whole crop:

States and Territories.	Merchantable.				Unmerchantable.			
	Bushels.	Per cent.	Price per bushel.	Value.	Bushels.	Per cent.	Price per bushel.	Value.
Maine	308,250	75	$0.59	$181,868	102,750	25	$0.23	$23,633
New Hampshire	691,650	87	.56	387,324	103,350	13	.33	34,106
Vermont	1,257,520	88	.57	716,786	171,480	12	.32	54,874
Massachusetts	1,260,150	93	.55	693,083	94,850	7	.33	31,301
Rhode Island	174,400	80	.72	125,568	43,600	20	.27	11,772
Connecticut	982,400	80	.61	599,264	245,600	20	.32	78,592
New York	11,746,350	77	.54	6,343,029	3,508,650	23	.31	1,087,682
New Jersey	5,886,780	82	.49	2,884,522	1,292,220	18	.25	323,055
Pennsylvania	23,711,240	76	.30	7,113,372	7,487,760	24	·27	2,021,695
Delaware	4,326,960	88	.39	1,687,514	590,040	12	.20	118,008
Maryland	12,363,960	82	.48	5,934,701	2,714,040	18	.28	759,931
Virginia	23,737,840	76	.46	10,919,406	7,496,160	24	.25	1,874,040
North Carolina	23,064,580	77	.51	11,762,936	6,889,420	23	.25	1,722,355
South Carolina	10,375,830	83	.63	6,536,773	2,125,170	17	.24	510,041
Georgia	28,626,300	85	.59	16,889,517	5,051,700	15	.29	1,464,993
Florida	4,123,560	84	.66	2,721,550	785,440	16	.34	267,050
Alabama	24,362,940	86	.59	14,374,135	3,966,060	14	.26	1,031,176
Mississippi	22,977,130	89	.61	14,016,049	2,839,870	11	.20	567,974
Louisiana	12,324,960	81	·63	7,764,725	2,891,040	19	·25	722,760
Texas	48,936,800	80	·51	24,957,768	12,234,200	20	·32	3,914,944
Arkansas	26,973,240	84	·51	13,756,352	5,137,760	16	·28	1,438,573
Tennessee	55,375,500	87	·40	22,150,200	8,274,500	13	·22	1,820,390

States and Territories.	Merchantable. Bushels.	Per cent.	Price per bushel.	Value.	Unmerchantable. Bushels.	Per cent.	Price per bushel.	Value.
West Virginia	10,848,530	77	$0·52	$5,641,236	3,240,470	23	$0·29	$939,736
Kentucky	55,766,560	82	·43	23,979,621	12,241,440	18	·23	2,815,531
Ohio	54,813,950	85	·37	20,281,162	9,673,050	15	·22	2,128,071
Michigan	16,779,070	77	·39	6,543,837	5,011,930	23	·18	902,147
Indiana	70,856,270	83	·35	24,799,695	14,512,730	17	·22	3,192,801
Illinois	144,495,000	90	·31	44,793,450	16,055,000	10	·20	3,211,000
Wisconsin	23,454,360	81	·34	7,974,482	5,501,640	19	·21	1,155,344
Minnesota	22,342,560	89	·32	7,149,619	2,761,440	11	·18	497,059
Iowa	239,240,400	95	·25	59,810,100	12,591,600	5	·15	1,888,740
Missouri	140,796,220	89	·30	42,238,866	17,401,780	11	·21	3,654,374
Kansas	104,592,750	75	·29	30,331,898	34,864,250	25	·24	8,367,420
Nebraska	133,687,150	85	·23	30,748,045	23,591,850	15	·18	4,246,533
South Dakota	19,896,640	97	·27	5,372,093	615,360	3	·20	123,072
North Dakota	400,320	96	·35	140,112	16,680	4	·15	2,502
Montana	28,800	96	·53	15,264	1,200	4	·30	360
Wyoming	36,100	95	·50	18,050	1,900	5	·25	475
Colorado	1,502,940	74	·41	616,205	528,060	26	·25	132,015
New Mexico	502,440	79	·72	361,757	133,560	21	·28	37,397
Arizona	61,500	75	·67	41,205	20,500	25	·25	5,125
Utah	132,480	72	·54	71,539	51,520	28	·30	15,456
Nevada	......	......	......	......	......	......	......	......
Idaho	28,800	90	·55	15,840	3,200	10	·25	800
Washington	166,470	93	·51	84,900	12,530	7	·26	3,258
Oregon	268,920	83	·54	145,217	55,080	17	·28	15,422
California	2,070,250	91	·39	807,398	204,750	9	·25	51,188
Total	1,386,356,820	85·6	·349	484,498,033	233,137,180	14·4	.228	53,264,771

VALUE OF THE CORN CROP.

The massed value of the corn crop of 1893, as estimated in the December report, was $591,625,627, or an average value of 36·5 cents per bushel against 39·4 cents and 40·6 cents for the years 1892 and 1891, respectively. The total value of the crop of both grades, i. e., merchantable, and unmerchantable, as shown by the returns of March 1, is $537,762,804, or about fifty-four millions less than the value as given in the returns of December last for the whole. The discrepancy is in part explained by the fact of grading in the later returns.

The export prices, or the prices per bushel at points of shipment, are given for the past fourteen years in the following table:

Year ending June 30.	Price.	Year ending June 30.	Price.
	Cents.		*Cents.*
1880	54·3	1887	48
1881	55·2	1888	55
1882	66·8	1889	47·4
1883	68·4	1890	41·8
1884	61·1	1891	57·4
1885	54	1892	55·1
1886	49·8	1893	53

WHEAT.

The indicated stock of wheat in farmers' hands on the 1st of March, 1894, is 114,000,000 bushels, or 28·8 per cent of the volume of last year's crop. This is nearly 21,000,000 bushels less than the estimate for March 1, 1893, and nearly 20,000,000 less than the average for the last six years.

The returns also indicate that a very considerable proportion of the wheat now in farmers' hands comes from crops grown prior to 1893,

This is chiefly from the crops of 1891 and 1892, but some is from crops prior to those. Such stocks have been held principally by large growers. Some damage to such stocks is reported from Michigan and Washington, and from a few points in other States. The amount remaining in farmers' hands is divided as follows: Winter wheat, eighty-three and one-half million and spring wheat thirty and one-half million bushels.

The following table shows the amounts remaining in farmers' hands from 1883 to 1894, inclusive. The average for the twelve years is something over 132,000,000 bushels.

Year.	Crops of previous years.	In farmers' hands March 1.		Year.	Crops of previous years.	In farmers' hands March 1.	
	Bushels.	*Bushels.*	*Per ct.*		*Bushels.*	*Bushels.*	*Per ct.*
1894	396, 132, 000	114, 000, 000	28·8	1888	456, 329, 000	132, 000, 000	28·9
1893	515, 949, 000	135, 000, 000	26·2	1887	457, 218, 000	122, 000, 000	26·7
1892	611, 780, 000	171, 000, 000	28	1886	357, 112, 000	107, 000, 000	30·1
1891	399, 262, 000	112, 000, 000	28·2	1885	512, 765, 000	169, 000, 000	33
1890	490, 560, 000	156, 000, 000	31·9	1884	421, 068, 160	119, 000, 000	28. 3
1889	415, 868, 000	112, 000, 000	26·9	1883	504, 185, 470	143, 000, 000	28·4

The following table presents the official estimates of production and the distribution for food, seed, and exportation for the years 1882 to 1892, inclusive. The aggregate of these estimates of production is 5,142,000,000 bushels. From this has been exported to foreign countries, in grain and flour, about 1,482,000,000 bushels; the amount used for seed has been near 592,000,000 bushels, and for food on the basis of 4⅔ bushels per head as heretofore estimated by the Department, 3,055,000,000 bushels, making a total of about 5,129,000,000 bushels distributed.

Year.	Production.	For food.	For seed.	Exportations.	Total distributed.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1882	504, 185, 470	250, 000, 000	52, 770, 312	147, 811, 316	450, 581, 628
1883	421, 086, 160	256, 000, 000	54, 683, 389	111, 534, 182	422, 217, 571
1884	512, 765, 000	261, 000, 000	55, 266, 239	132, 570, 367	548, 836, 606
1885	357, 112, 000	267, 000, 000	51, 474, 906	94, 565, 794	413, 040, 700
1886	457, 218, 000	271, 000, 000	51, 528, 658	153, 804, 970	476, 333, 628
1887	456, 329, 000	277, 000, 000	53, 009, 982	119, 625, 344	449, 635, 326
1888	415, 868, 000	283, 000, 000	54, 012, 702	88, 600, 743	425, 613, 445
1889	490, 560, 000	289, 000, 000	53, 973, 000	109, 430, 467	452, 403, 467
1890	399, 262, 000	295, 000, 000	56, 582, 000	106, 181, 316	457, 763, 316
1891	611, 780, 000	302, 000, 000	54, 508, 000	225, 665, 812	582, 173, 812
1892	515, 949, 000	304, 000, 000	54, 000, 000	191, 912, 635	549, 912, 635
Total	5, 142, 114, 630	3, 055, 000, 000	591, 809, 188	1, 481, 702, 946	5, 128, 512, 134
Average	467, 464, 966	277, 727, 273	53, 800, 835	134, 700, 268	466, 228, 376

The reports of the correspondents of the Department throughout the great wheat-surplus States indicate a new factor in the consumption of wheat, viz, the feeding of that grain to hogs and other stock, a fact due, as declared, to the unprecedentedly low prices, the claim being made that this mode of disposing of the cereal is profitable as compared with marketing it for human food.

The following tables show, first by sections, second by States, the crop of 1893, the stock in farmers' hands on March 1, 1894, the amount consumed in the county where grown, and the amount shipped out of the county where grown:

Sections.	Crop of 1893.	Stock on hand Mar. 1, 1894.		Estimated for county consumption.		Distribution beyond county lines.	
	Bushels.	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*
New England	245,000	79,770	32·6	238,760	97·5	6,240	2·5
Middle	28,454,000	12,137,080	42·7	16,146,140	56·7	12,307,860	43·3
Southern	37,767,000	10,442,510	27·6	24,334,530	64·4	13,432,470	35·6
Western	267,381,000	72,224,230	27	96,754,220	36·2	170,626,780	63·8
Mountain Region	6,758,000	1,902,780	28·2	3,543,860	52·4	3,214,140	47·6
Pacific	55,527,000	17,273,190	31·1	13,001,260	23·4	42,525,740	76·6
Total	396,132,000	114,059,560	28·8	154,018,770	38·9	242,113,230	61·1

States and Territories.	Crop of 1893.	Stock on hand Mar. 1, 1894.		Consumed in county where grown.		Shipped out of county where grown.	
	Bushels.	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*
Maine	72,000	15,120	21	71,280	99	720	1
New Hampshire	35,000	9,450	27	35,000	100	....	....
Vermont	138,000	55,200	40	132,480	96	5,520	4
New York	6,846,000	2,875,320	42	4,176,060	61	2,669,940	39
New Jersey	1,794,000	681,720	38	1,291,680	72	502,320	28
Pennsylvania	18,352,000	8,258,400	45	10,093,600	55	8,258,400	45
Delaware	1,462,000	321,640	22	584,800	40	877,200	60
Maryland	6,722,000	1,546,060	23	3,024,900	45	3,697,100	55
Virginia	8,681,000	2,864,730	33	4,514,120	52	4,166,880	48
North Carolina	5,938,000	2,078,300	35	5,462,960	92	475,040	8
South Carolina	927,000	185,400	20	927,000	100	....	....
Georgia	1,733,000	346,600	20	1,646,350	95	86,650	5
Alabama	393,000	66,810	17	357,630	91	35,370	9
Mississippi	27,000	....	....	27,000	100	....	....
Texas	4,533,000	906,600	20	3,490,410	77	1,042,590	23
Arkansas	1,370,000	438,400	32	1,013,800	74	356,200	26
Tennessee	7,443,000	2,009,610	27	3,870,360	52	3,572,640	48
West Virginia	4,578,000	1,510,740	33	3,433,500	75	1,144,500	25
Kentucky	10,584,000	2,857,680	27	5,715,360	54	4,868,640	46
Ohio	38,917,000	13,620,950	35	17,901,820	46	21,015,180	54
Michigan	19,921,000	5,976,300	30	7,769,190	39	12,151,810	61
Indiana	35,579,000	9,250,540	26	13,520,020	38	22,058,980	62
Illinois	15,507,000	4,031,820	26	4,962,240	32	10,544,760	68
Wisconsin	8,664,000	2,429,920	28	5,458,320	63	3,205,680	37
Minnesota	30,695,000	7,673,750	25	8,287,650	27	22,407,350	73
Iowa	6,749,000	2,362,150	35	3,914,420	58	2,834,580	42
Missouri	15,288,000	4,127,760	27	6,115,200	40	9,172,800	60
Kansas	23,252,000	5,115,440	22	6,510,560	28	16,741,440	72
Nebraska	10,688,000	3,847,680	36	4,275,200	40	6,412,800	60
South Dakota	20,521,000	4,925,040	24	4,925,040	24	15,595,960	76
North Dakota	26,438,000	4,494,460	17	3,965,700	15	22,472,300	85
Montana	934,000	373,600	40	495,020	53	438,980	47
Wyoming	95,000	31,350	33	95,000	100	....	....
Colorado	1,817,000	454,250	25	599,610	33	1,217,390	67
New Mexico	665,000	139,650	21	578,550	87	86,450	13
Arizona	192,000	63,360	33	167,040	87	24,960	13
Utah	1,458,000	379,080	26	874,800	60	583,200	40
Nevada	82,000	22,140	27	67,240	82	14,760	18
Idaho	1,515,000	439,350	29	666,600	44	848,400	56
Washington	9,884,000	3,953,600	40	1,482,600	15	8,401,400	85
Oregon	10,791,000	3,561,030	33	2,805,660	26	7,985,340	74
California	34,852,000	9,758,560	28	8,713,000	25	26,139,000	75
Total	396,132,000	114,059,560	28·8	154,018,770	38·9	242,113,230	61·1

Average farm prices of wheat for the years 1880–1893.

States.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
Kentucky	$0.93	$1.31	$0.90	$0.95	$0.74	$0.95	$0.72
Ohio	1.02	1.29	.95	.99	.75	.91	.74
Michigan	.97	1.25	.90	.96	.74	.84	.73
Indiana	.99	1.27	.90	.95	.67	.86	.70
Illinois	.95	1.22	.86	.92	.63	.81	.69
Wisconsin	1.00	1.19	.90	.88	.60	.76	.68
Minnesota	.87	1.06	.82	.80	.50	.70	.61
Iowa	.82	1.06	.70	.80	.55	.67	.60
Missouri	.89	1.19	.85	.88	.62	.77	.63
Kansas	.70	1.05	.67	.78	.45	.65	.58
Nebraska	.73	.97	.67	.70	.42	.57	.47
South Dakota } North Dakota }	....	....	.80	.72	.46	.63	.52
United States	.951	1.192	.882	.911	.645	.771	.687

Average farm prices of wheat for the years 1880–1893—Continued.

States.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
Kentucky	$0.73	$0.96	$.072	$0.92	$0.90	$0.67	$0.57
Ohio	.75	.97	.76	.91	.92	.68	.57
Michigan	.74	.98	.74	.90	.91	.67	.57
Indiana	.72	.94	.71	.88	.86	.64	.53
Illinois	.70	.93	.70	.87	.85	.63	.51
Wisconsin	.64	.96	.70	.83	.84	.62	.54
Minnesota	.59	.92	.71	.81	.78	.61	.51
Iowa	.61	.85	.63	.80	.81	.60	.49
Missouri	.62	.88	.64	.83	.80	.58	.48
Kansas	.61	.88	.55	.77	.73	.52	.42
Nebraska	.53	.83	.52	.76	.73	.50	.40
South Dakota	.52	.91	.60	.70	.72	.51	.44
North Dakota					.70	.52	.43
United States	.681	.926	.698	.838	.839	.624	.538

Average export price of wheat.

Year.	Average price.	Year.	Average price.
1877–'78	$1.34	1885–'86	$0.870
1878–'79	1.07	1886–'87	.890
1879–'80	1.24	1887–'88	.853
1880–'81	1.11	1888–'89	.897
1881–'82	1.19	1889–'90	.832
1882–'83	1.13	1890–'91	.933
1883–'84	1.07	1891–'92	1.03
1884–'85	.862	1892–'93	.80

Weight of wheat per bushel.

Year.	Weight per bushel.	Measured bushels.	Weight in pounds.	Bushels of 60 pounds.
1885	57·0	357,112,000	20,369,787,000	339,496,449
1886	58·4	457,218,000	26,686,632,000	444,777,202
1887	58·5	456,329,000	26,702,852,300	445,047,538
1888	56·5	415,868,000	23,485,066,800	391,417,782
1889	57·7	490,560,000	28,287,039,600	471,460,663
1890	57·2	399,262,000	22,854,954,200	380,915,903
1891	58·5	611,780,000	35,758,807,400	595,980,127
1892	57·5	515,949,000	29,661,220,000	494,353,667
1893	57·6	396,132,000	22,833,692,000	380,561,533

Wheat crop of 1893.

States and Territories.	Weight per bushel.	Bushels of crop, 1893.	Weight in pounds.	Bushels of 60 pounds.
	Pounds.			
Maine	58	72,000	4,176,000	69,600
New Hampshire	51	35,000	1,785,000	29,750
Vermont	57	138,000	7,866,000	131,100
Connecticut	58	....	....	....
New York	56	6,846,000	383,376,000	6,389,600
New Jersey	60	1,794,000	107,640,000	1,794,000
Pennsylvania	59	18,352,000	1,082,768,000	18,046,133
Delaware	58	1,462,000	84,796,000	1,413,267
Maryland	59	6,722,000	396,598,000	6,609,967
Virginia	59	8,681,000	512,179,000	8,536,317
North Carolina	59	5,938,000	350,342,000	5,839,033
South Carolina	57	927,000	52,839,000	880,650
Georgia	57	1,733,000	98,781,000	1,646,350
Alabama	56	393,000	22,008,000	366,800
Mississippi	....	27,000	....	....
Texas	57	4,533,000	258,381,000	4,306,350
Arkansas	58	1,370,000	79,460,000	1,324,333

Wheat crop of 1893—Continued.

States and Territories.	Weight per bushel.	Bushels of crop, 1893.	Weight in pounds.	Bushels of 60 pounds.
	Pounds.			
Tennessee	58	7,443,000	431,694,000	7,194,900
West Virginia	59	4,578,000	270,102,000	4,501,700
Kentucky	58	10,584,000	613,872,000	10,231,200
Ohio	59	38,917,000	2,296,103,000	38,268,383
Michigan	58	19,921,000	1,155,418,000	19,256,967
Indiana	58	35,579,000	2,063,582,000	34,393,033
Illinois	55	15,507,000	852,885,000	14,214,750
Wisconsin	56	8,664,000	485,184,000	8,086,400
Minnesota	56	30,695,000	1,718,920,000	28,648,667
Iowa	57	6,749,000	384,693,000	6,411,550
Missouri	55	15,288,000	840,840,000	14,014,000
Kansas	55	23,252,000	1,278,860,000	21,314,333
Nebraska	57	10,688,000	609,216,000	10,153,600
South Dakota	57	20,521,000	1,169,697,000	19,494,950
North Dakota	58	26,438,000	1,533,404,000	25,556,733
Montana	61	934,000	56,974,000	949,567
Wyoming	59	95,000	5,605,000	93,417
Colorado	59	1,817,000	107,203,000	1,786,717
New Mexico	59	665,000	39,235,000	653,917
Arizona	59	192,000	11,328,000	188,800
Utah	59	1,458,000	86,022,000	1,433,700
Nevada	60	82,000	4,920,000	82,000
Idaho	51	1,515,000	77,265,000	1,287,750
Washington	59	9,884,000	583,156,000	9,719,267
Oregon	61	10,791,000	658,251,000	10,970,850
California	59	34,852,000	2,056,268,000	34,271,133
Total and average	57.6	396,132,000	22,833,092,000	380,561,533

Wheat inspection.

NEW YORK.

Grades.	1889.		1890.		1891.		1892.		1893.		Average for 5 years.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
Winter:												
State and extra	162	6·1	75	1·4	146	·5	148	·5	41	·3	114	·5
No. 1	18	·7	30	·5	42	·2	53	·2	4	......	29	·1
No. 2	667	25·4	1,518	27·7	20,480	68·9	19,084	64·1	5,271	32·8	9,404	35·6
No. 3	633	24·1	75	1·4	638	2·1	1,380	4·6	429	2·7	631	2·4
All other	1,149	43·7	3,788	69	8,421	28·3	9,099	30·6	3,842	23·9	5,259	19·9
Spring:												
No. 1	1,229	58·1	1,891	43·1	11,437	60·9	13,210	58·6	3,593	22·3	6,272	23·7
No. 2	263	12·4	1,101	25·1	3,928	20·9	4,241	18·2	329	2·0	1,972	7·4
No. 3	......	......	......	......	249	1·3	69	·3	......	......	63	·2
All other	624	29·5	1,396	31·8	3,164	16·9	5,797	24·9	2,563	16·0	2,708	10·2
Total	4,745	......	9,874	......	48,505	......	53,081	......	16,072	......	26,452	......
Winter	2,629	55·5	5,486	55·4	29,727	61·3	29,764	56·1	9,587	59·7	15,437	58·4
Spring	2,116	44·6	4,388	44·4	18,778	38·7	23,317	43·9	6,485	40·3	11,015	41·6

DETROIT.

Grades.	1888.		1889.		1890.		1891.		1892.		1893.		Average for 6 years.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
No. 1	3,012	22	1,569	17·6	2,071	23·8	2,467	18·9	2,491	17·5	1,956	13·7	2,261	18·6
No. 2	5,963	43·6	4,127	46·2	4,982	57·2	8,979	68·8	7,938	55·9	9,658	67·4	6,941	57·1
No. 3	3,582	26·2	2,373	26·5	796	9·1	353	2·7	2,513	17·7	1,674	11·7	1,882	15·5
All other	1,121	8·2	867	9·7	867	9·9	1,245	9·6	1,267	8·9	1,036	7·2	1,067	8·8
Total	13,678	.....	8,936	.....	8,716	.....	13,044	.....	14,209	.....	14,324	.....	12,151	.....

Wheat inspection—Continued.

MILWAUKEE.

Grades.	1889.		1890.		1891.		1892.		1893.		Average for 5 years.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
Spring:												
No. 1	603	9·2	834	12·9	1,328	15·1	1,644	15·4	4,460	35·2	1,774	15·3
No. 2	596	9·1	1,047	16·2	1,647	18·7	1,269	11.9	1,387	10·9	1,189	10·3
No. 3	1,675	25·6	2,182	33·7	4,052	46·1	5,444	50·9	3,701	29·2	3,411	29·4
No. 4	2,726	41·6	1,822	28·1	1,412	16·1	2,325	21·7	574	4·5	1,772	15·3
All other	951	14·5	590	9·1	350	4	10	·1	124	1·0	405	3·5
Winter												
No. 2	505	26·5	595	24·7	851	49·0	4,013	77·4	1,488	11·8	1,490	12·8
No. 3	1,058	55·5	1,492	61·9	723	42·2	1,048	20·2	652	5·1	997	8·6
All other	344	18	323	13·4	154	8·8	125	2·4	....	......	189	1·6
Mixed winter and spring:												
No. 2	256	63·4	390	63·4	219	75·8	227	80·8	178	1·4	254	2·2
No. 3	148	36·6	225	36·6	70	24·2	54	19·2	110	·9	121	1
Total	8,862	......	9,500	......	10,816	......	16,159	......	*12,674	......	11,602	.....
Spring	6,551	73·9	6,475	68·1	8,789	81·2	10,692	66·2	10,246	......	8,551	73·7
Winter	1,907	21·5	2,410	25·4	1,738	16·1	5,186	32·1	2,140	......	2,676	23·1
Mixed winter and spring	404	4·6	615	6·5	289	2·7	281	1·7	288	......	375	3·2

*6,726 cars received in 1893 were not inspected. This would make the total receipts 19,400 carloads.

CHICAGO.

Grades.	1888.		1889.		1890.		1891.		1892.		1893.		Average for 6 years.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
Winter:														
No. 1	8	.....	......	.....	7	.....	6	.....	219	·4	2	.....	40	·1
No. 2	3,763	26	5,282	22·6	7,303	47·4	18,195	37·8	21,268	37·8	7,179	12·1	10,499	19·8
No. 3	7,601	52·2	14,276	61·2	6,197	40·2	22,910	47·6	28,213	50·2	16,511	27·9	15,951	30·1
Below 3	3,165	21·8	3,766	16·2	1,918	12·4	7,020	14·6	6,536	11·6	2,994	5·1	4,233	8
Spring:														
No. 1	......	.....	2	.....	......	.....	3	.....	1	.....	......	.....	1	.....
No. 2	4,746	39·6	6,593	49·2	5,884	40·5	11,864	38	8,504	28·6	13,352	22·6	8,491	16
No. 3	5,059	42·2	4,306	32·1	6,840	47	16,519	52·9	16,655	56	17,118	28·9	11,083	21
Below 3	2,188	18·2	2,504	18·7	1,821	12·5	2,827	9·1	4,594	15·4	1,995	3·4	2,655	5
Total	26,530	.....	36,729	.....	29,970	.....	79,344	.....	85,990	.....	59,151	.....	52,952	.....
Winter	14,537	51·8	23,324	63·5	15,425	51·5	48,131	60·7	56,236	65·4	26,686	45·1	30,723	58
Spring	11,993	45·2	13,405	36·5	14,545	48·5	31,213	39·3	29,754	34·6	32,465	54·9	22,229	42

ST. LOUIS.

Grades.	1888.		1889.		1890.		1891.		1892.		1893.		Average for 6 years.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
Winter:														
No. 1	......	.....	2	.....	9	.....	......	.....	1	.....	......	.....	2	.....
No. 2	3,274	22	5,724	39·8	7,328	56·4	16,644	57·7	11,444	46·2	7,392	45	8,634	42·9
No. 3	6,129	41·1	4,787	33·3	3,089	23·8	7,519	26·1	6,793	27·4	5,257	32	5,597	27·8
No. 4	2,670	17·9	1,317	9·2	1,049	8·1	2,346	8·1	3,816	15·4	2,286	13·9	2,246	11·1
Rejected	2,360	15·8	2,227	15·5	1,142	8·8	1,921	6·7	2,500	10·1	1,062	6·5	1,869	9·3
Other	477	3·2	331	2·2	370	2·9	420	1·4	227	·9	292	1·8	353	1·8
Spring:														
No. 2	24	17·9	2	2·9	68	34·4	273	35·9	5,159	70·1	41	·2	928	4·6
No. 3	68	50·7	2	2·9	83	41·9	369	48·5	1,560	21·2	70	·4	359	1·8
Rejected	38	28·4	63	91·3	41	20·7	119	15·6	370	5	27	·2	110	·5
Other	4	3	2	2·9	6	3	......	.....	274	3·7	......	.....	48	·2
Total	15,044	.....	14,457	.....	13,185	.....	29,611	.....	32,149	.....	16,427	.....	20,146	.....
Winter	14,910	99·1	14,388	99·5	12,987	98·5	28,850	97·4	24,786	77·1	16,289	*99·2	18,702	92·8
Spring	134	·9	69	·5	198	1·5	761	2·6	7,363	22·9	138	·8	1,444	7·2

*Besides this, 1,005,557 sacks of wheat were inspected in this market, graded as follows: No. 2 red winter, 590,727; No. 3 red, 247,253; No. 4 red, 112,415; rejected, 47,370; no grade, 7,792 sacks.

Wheat inspection—Continued.

MINNEAPOLIS.

Grades.	1888.		1889.		1890.		1891.		1892.		1893.		Average for 6 years.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
No. 1	38,872	55·1	43,914	61·5	44,512	59·9	60,596	64·2	61,083	53·7	62,407	70·4	51,897	60·7
No. 2	15,407	21·8	13,407	18·8	18,169	24·4	16,363	17·3	24,274	21·3	16,655	18·8	17,369	20·3
No. 3	4,442	6·3	6,060	8·5	5,446	7·3	6,008	6·4	8,698	7·6	2,553	2·9	5,534	6·4
Rejected	6,773	9·6	4,888	6·9	3,487	4·7	6,042	5·7	7,286	6·4	5,774	6·5	5,708	6·8
Other	5,057	7·2	3,050	4·3	2,736	3·7	5,424	6·4	12,515	11	1,244	1·4	5,004	5·8
Total	70,551	.....	71,319	.....	74,350	.....	94,433	.....	113,856	.....	88,633	.....	85,523	.....

SUPPLY AND DISTRIBUTION OF WHEAT FOR TWENTY-FIVE YEARS.

It has for many years been assumed in all estimates of food consumption made by this Department that the average quantity of wheat consumed in the United States is 4⅔ bushels per capita. On this basis, with a population estimated for September 1, 1893 (midway between March 1, 1893, and March 1, 1894), at 67,188,250, the total quantity of wheat consumed for food in the United States would be, in round numbers, 314,000,000 bushels. The consumption for seed in the spring and fall of 1893 is estimated at 49,000,000 bushels, making a total of 363,-000,000. Adding to this the exports, the visible supply on March 1, 1894, and the supply in farmers' hands at the same date, as shown by recent returns to this Department, we get the following statement as to the distribution of the wheat supply during the year ending March 1, 1894:

		Millions of bushels.
Consumption for food		314
Consumption for seed		49
Exports		176
Visible supply March 1, 1894		76
Supply in farmers' hands March 1, 1894		114
Total distribution		729
The supply, on the other hand, was reported as follows:		
Visible supply March 1, 1893	79	
Supply in farmers' hands March 1, 1893	135	
Crop of 1893	396	
Total supply		610
Apparent discrepancy		119

There is reason to doubt, however, whether the consumption of wheat for food during the year ending March 1, 1894, has been as great as 4⅔ bushels per capita. It is not probable that there has been any reduction in the quantity of wheat bread actually eaten, but in the matter of waste there was a wide margin for retrenchment. During the pinching times of the past fall and winter many a crust and many a fragment of stale bread which ordinarily would have found its way to the swill barrel has undoubtedly been used to satisfy human hunger or to ward it off. This has been the case not merely in occasional instances but in thousands of families; for, besides the cases of pinching want arising from actual loss of employment, there has been a still

larger number in which employment has been only partial, or in which wages have been materially reduced. Even among many of those in comfortable circumstances there has been increased care in the saving of food for the benefit of the needy on whose behalf the appeals for help have been so frequent and so urgent. If the cheapness of wheat during the period in question may seem to have been favorable to a continued use of an unstinted supply of bread, it must be observed, on the other hand, that the price of baker's bread has not generally fallen, and that the large proportion of our urban populations who depend on such bread have not received the normal benefit due them as a result of the low price of wheat.

Another point which has a bearing on the extent to which the supply, as indicated above, has been drawn upon for actual consumption is found in the extreme probability that the supply in the hands of consumers and dealers is in the aggregate considerably smaller than it was a year ago. This "invisible" part of the total supply has been tacitly assumed to be constant, and therefore has cut no figure in the current discussions of supply and distribution. But there can be no doubt that in periods of business depression there is a large body of consumers whose lack of means to make fresh purchases leads them to use up the supplies on hand much more closely and stintingly than ordinarily. This condition of affairs reacts to a greater or less extent on the dealers who supply such consumers, causing a postponement of purchases on their part corresponding to the postponement of the exhaustion ot their stocks due to the like action on the part of their customers.

After the change has once gone into effect the stream of supply will flow on in the usual volume unless there has been an actual decrease of consumption; but if such a change in the habits of a large body of consumers took place between March 1, 1893, and March 1, 1894, its effects would inevitably appear in a comparison of the stocks on hand at the two dates, since those on hand on March 1, 1894, would necessarily be larger than they would have been had the "invisible supply" between the wheat market and the consumer's mouth been kept up to its customary level. In other words, for every million bushels represented by a reduction of this invisible supply there is just a million bushels more in the visible supply or the supply in farmers' hands than there would have been if the invisible supply had not been so reduced.

How far a proper allowance on the score of such considerations as those just presented would go towards removing the discrepancy between supply and distribution, as above presented, it is, of course, difficult to estimate with exactness; and it may not be worth while to attempt any estimate, in figures, under such conditions.

It should, perhaps, be noted in this connection that according to one very recent commercial estimate which has attracted considerable attention, the stock in farmers' hands on March 1, 1893, was 87,000,000 bushels greater than the estimate of the Department of Agriculture made it. The figures compare as below:

	Bushels.
Recent commercial estimate	222, 000, 000
Official statement in March, 1893	135, 000, 000
Difference	87, 000, 000

The same estimate makes the wheat crop of 1893 to have been 460,000,000 bushels, or 64,000,000 bushels in excess of the estimate of this Department, and infers also from "a careful and thorough review of the data of distribution" for the years 1890, 1891, and 1892 that the

Department underestimated the crops of those years by an amount aggregating 177,000,000 bushels, an average annual underestimate for those years of 59,000,000 bushels.

It is not intended here to discuss the commercial estimate just cited. In any case it is not to be taken for granted that the apparent discrepancy between the figures on supply and those on distribution for March 1, 1894, is chargeable wholly, or even to any considerable extent, to the official estimates for the last year. To say nothing of the possibility that preceding crops have been underestimated—and in years of exceptional abundance, such as 1891 and 1892, there was a manifest tendency in that direction—authorities are far from being unanimous, as many writers assume them to be, in regard to the average consumption of wheat per capita for human food.

Either an underestimate of production or an overestimate of consumption in preceding years would imply that the stock in existence on March 1, 1893, in farmers' hands or elsewhere, was larger than computed; and, if so, there has been more to draw upon during the past twelve months than the 610,000,000 bushels shown by the figures already presented. No pretension is made to infallibility on the part of the Statistical Division of the Department of Agriculture. It, of course, aims at exactness and honestly endeavors to attain it, but it can promise no more than approximations to the desired knowledge. Its crop reports, however, cover a vast field of inquiry as to the factors involved in estimating production; and it certainly has not neglected during the past year to make full use of its large facilities for obtaining correct information.

It has been said above that authorities are not agreed as to the average consumption of wheat per capita in the United States. Mr. Edward Atkinson, who has given careful study to the question of food consumption, says:* "The average ration of wheat flour to each adult person in the United States is well ascertained to be 1 barrel each year." He rates as adults all persons of 10 years old and upwards, and counts 2 children under 10 as the equivalent of 1 adult in respect to their consumption of this item of food. Assuming the ratio between such children and the total population to have been the same as that shown by the census of 1890, and estimating the total population for September 1 of each year on the basis of the census figures for June, 1890, and the estimates of the Government actuary for June 1 in each of the other years, we have the following figures for the last five years:

Years.	Estimates for Sept. 1. Total population.	Estimates for Sept. 1. Equivalent in persons of 10 years and upwards.
1889	61,622,313	54,139,392
1890	62,967,188	55,320,956
1891	64,352,250	56,537,828
1892	65,758,750	57,773,533
1893	67,188,250	59,029,446

The per capita estimate, always used by our predecessors in the Department, would give a consumption of $4\frac{2}{3}$ bushels per capita on the population shown in the left hand column; whereas the estimate used by Mr. Atkinson would give us an average consumption of 1 barrel of flour

*See his "Industrial Progress of the Nation," pp. 34 to 38, inclusive. Care should be taken by the reader to keep in mind the distinction between per capita and per adult in what follows.

each on the smaller numbers presented on the right. Taking all grades of flour into account the average quantity of wheat to the barrel can hardly be more than 4⅗ nor less than 4½ bushels. Bringing together the figures on distribution and supply for the twelve months ending March 1, 1894, on each of these hypotheses as to the consumption of wheat for food, we get, in millions of bushels, the following statement:

Items.	Consumption at—	
	4⅗ bushels per adult.	4½ bushels per adult.
Distribution:		
Exports	176	176
Consumption for seed	49	49
Consumption for food	275	266
Visible supply March 1, 1894	76	76
In farmers' hands March 1, 1894	114	114
Total	690	681
Supply (as shown above)	610	610
Apparent discrepancy	80	71

If the consumption for food during the past twelve months, after making allowance for the increased quantity of wheat fed to animals, has been smaller than usual, or if, as we have seen reason to believe, it has come in part out of what may be called the "invisible supply" in existence on March 1, 1893, and not wholly out of the 610,000,000 bushels comprised in the supply as set down above, the discrepancy which, on the basis of the Atkinson estimate of flour consumption in ordinary years, would, as we have just seen, be from 71,000,000 to 80,000,000 bushels, will, of course, be still further reduced.

It has been stated above that, according to one commercial estimate cited, the supply of wheat in farmers' hands on March 1, 1893, was 222,000,000 bushels. This is 87,000,000 bushels in excess of the estimate of the Department of Agriculture for the same date, Mr. Dodge's figures making the wheat in farmers' hands on March 1, 1893, to have been only 135,000,000 bushels.* It is claimed, moreover, that the commercial estimate in question is the result of special, independent investigation, and not a mere derivative whose correctness is dependent on that of other items of the same estimate; and it consequently admits of consideration apart from these other items. Suppose, then, that we experimentally substitute it for the Department figures on "supply in farmers' hands" in each of the foregoing statements as to supply and distribution for the year ending March 1, 1894, and note the result of the change, the quantities being given in millions of bushels.

Items.	Supply.	Distribution. A.	Supply.	Distribution. B.	Supply.	Distribution. C.
Visible supply Mar. 1, 1893	79		79		79	
In farmers' hands Mar. 1, 1893	222		222		222	
Crop of 1893	396		396		396	
Exported during year		176		176		176
Used for seed		49		49		49
Used for food		314		275		266
Visible supply Mar. 1, 1894		76		76		76
In farmers' hands Mar. 1, 1894		114		114		114
Totals	697	729	697	690	697	681
Apparent excess		32	7		16	

* The same commercial estimate makes the supply in farmers' hands on March 1, 1894, 138,000,000 bushels, or 24,000,000 bushels more than the quantity shown by the present statement of the Department on the same subject.

In column A the consumption for food is placed at $4\frac{2}{3}$ bushels per capita, in column B at $4\frac{2}{3}$ bushels per adult, and in column C at $4\frac{1}{2}$ bushels per adult, the word "adult" being used as already explained. All the items except the estimate for food consumption are alike in the three columns and the difference in the figures on total distribution is, therefore, the result of the difference in the estimates upon this one point. It will be seen that if the old official estimate for wheat consumption (that used in column A) be adhered to the distribution exceeds the supply by 32,000,000 bushels, while if the consumption is estimated on the Atkinson basis of 1 barrel of flour per adult the supply exceeds the distribution by 7,000,000 or by 16,000,000 bushels, according to the quantity of wheat taken as the equivalent of the barrel of flour. Thus, on the supposition that the quantity of wheat in farmers' hands on March 1, 1893, was as largely underestimated as is claimed by the commercial publication whose estimate has been thus tentatively used, the discrepancy between the figures on supply and those on distribution for the past year is reduced within very narrow limits. It is deemed more probable, however, that while the Department estimate as to wheat in farmers' hands a year ago may have been too low, the apparent deficiency in the supply, when compared with apparent distribution, has been covered in considerable part, as already suggested, by consumption out of the invisible supply rather than out of the visible supply or out of the stocks in the hands of farmers.

No opinion is here expressed as to the correctness of the estimate given by Mr. Atkinson. It is considerably lower than that heretofore used in the estimates of the Department of Agriculture and falls still a little further below the estimates of some of our agricultural and commercial papers. But the prominence of that writer and the careful attention he is known to have given to questions connected with the national food supply entitle to respectful consideration an estimate in which he has felt the degree of confidence indicated by his statement that "the average ration of wheat flour to each adult person in the United States is *well ascertained* to be 1 barrel each year." If we take $4\frac{1}{2}$ bushels of wheat as the equivalent of a barrel of flour, this estimate of 1 barrel of flour per adult will give an average for the entire population of rather more than 3·95 bushels per capita, and if we take $4\frac{2}{3}$ bushels to the barrel, it will give an average of nearly 4·1 bushels per capita. In view of the rather wide disparity between the estimates used by recognized authorities, a new and careful investigation on the subject of our average consumption of wheat seems desirable. But in the meantime it may not be amiss to remind those who adopt some of the higher figures that there is a large population in the South—particularly the colored people of that section, numbering over 7,600,000 in 1890—among whom corn is the staple cereal and wheat but little used.

Whatever may be the fact as to the rate of consumption for food, or as to other elements entering into the question of distribution and supply, it is obvious that the figures for a single year do not afford a basis of sufficient width to admit of erecting upon it a superstructure of trustworthy conclusions. Even in ordinary times the liability to error growing out of the increase of the "visible" supply at the expense of the "invisible" supply, or *vice versa*, during the year taken for examination would be considerable. And in such an exceptional year as the twelve months just closed, it would be markedly great. In crop estimates, estimates of consumption for seed and for food, and estimates of the supply in farmers' hands there is, of course, more or less liability to error. And there are also sources of uncertainty arising from the

existence of stocks of wheat and flour elsewhere than in those receptacles in which they receive the commercial name of "visible supply." Were the figures on supply and distribution complete, any discrepancy between them would demonstrate the existence of error at some point, while agreement, on the other hand, though not so conclusive, would at least afford a presumption in favor of the substantial accuracy of the estimates entering into each side of the account.

But in view of the incompleteness of existing data, especially such as would serve to show the total supply in the country, including flour, at any given time, a comparison for a single year, as already observed, can afford no adequate basis for trustworthy conclusions. If a longer period be taken, the disturbing effect of any change occurring after its commencement in the proportions between the known and the unknown elements of total supply in existence is lessened by distribution, and the possibility of drawing trustworthy inferences from the results of a comparison between the known or estimated elements of supply on the one side and distribution on the other is proportionately increased. Suppose, then, that we take a period of five years ending with the 1st of March, 1894, and see what results we shall obtain upon each of the suppositions heretofore mentioned in respect to the quantity of wheat consumed as food in the United States. The following table contains the available data for a comparison extending over a period of that length, quantities being expressed in millions of bushels:

Years ending Mar. 1—	Quantities produced. (a)	Quantities exported.	Quantities consumed.				Exports plus consumption.		
			For seed.	For food.					
				At $4\frac{2}{3}$ bushels per capita.	At 1 barrel of flour per adult assuming the wheat in 1 barrel to be—		Sum of columns 3, 4, and 5.	Sum of columns 3, 4, and 6.	Sum of columns 3, 4 and 7.
					$4\frac{2}{3}$ bushels.	$4\frac{1}{2}$ bushels.			
1	2	3	4	5	6	7	8	9	10
1890	490	98	54	288	253	244	440	405	396
1891	399	98	53	294	258	249	445	409	400
1892	612	206	56	300	264	254	562	526	516
1893	516	191	54	307	270	260	552	515	505
1894	396	176	49	314	275	266	539	500	491
Total	2,413	769	266	1,503	1,320	1,273	2,538	2,355	2,308

a It will, of course, be understood that the quantity produced during the year ending March 1, 1890, was the crop of 1889, and so on for the other years.

Striking a balance for the five years on each of these suppositions as to the consumption of wheat for food, we get in millions of bushels the following results:

	Supposition 1.		Supposition 2.		Supposition 3.	
	Supply.	Distribution.	Supply.	Distribution.	Supply.	Distribution.
Visible supply Mar. 1, 1889	32		32		32	
In farmers' hands Mar. 1, 1889	112		112		112	
Crops of 1889, 1890, 1891, 1892, and 1893	2,413		2,413		2,413	
Visible supply Mar. 1, 1894		76		76		76
In farmers' hands Mar. 1, 1894		114		114		114
Exports plus consumption Mar. 1, 1889, to Mar. 1, 1894		2,538		2,355		2,308
Total	2,557	2,728	2,557	2,545	2,557	2,498
Excess		171	12		59	

It thus appears that if we take the Atkinson estimate as to food consumption and allow $4\frac{1}{2}$ bushels of wheat to the barrel of flour, the supply exceeded the known distribution by 59,000,000 bushels, or an average of 11·8 million bushels a year. But if from the 59,000,000 bushels we should deduct the quantity used for other purposes than human food, including that fed to animals and any that may possibly have been used in distilleries or breweries, as well as the amounts lost by fire, shipwreck on the lakes, or otherwise, this average would be somewhat reduced. If we take the same estimate and allow $4\frac{2}{3}$ bushels to the barrel the excess of supply over the known distribution is only 12,000,000 bushels, or an average of 2·4 million bushels a year. This would, perhaps, be hardly sufficient to cover the quantities lost and used for other purposes than human food. But the correspondence between the figures on supply and those on distribution, on this hypothesis as to the consumption of food, is certainly exceedingly close.

Of the two estimates in regard to the quantity of wheat used in the production of a barrel of flour the lower is the one that for years past has been used by the Department in reducing flour to its equivalent in wheat; and information received from large milling firms, who keep accurate records on this subject, indicates that, taking both winter and spring wheat into account, $4\frac{1}{2}$ bushels is a sufficiently high average. Indeed, a somewhat lower one might seem justified; for one very important establishment returns the average for three years in the case of spring wheat at a small fraction less than $4\frac{1}{3}$ bushels of 60 pounds each, and estimates the average for winter wheat at about $4\frac{1}{2}$ bushels. The figures of the census would, however, indicate a general average for the year ending May 31, 1890, of 4·76 or, say, $4\frac{3}{4}$ bushels. The results differ from season to season, according to the quality of the crops, but ordinarily the difference is very small. The tendency is toward a reduction of the average as the use of the most improved milling machinery becomes more and more general throughout the country.

If, instead of the estimate used by Mr. Atkinson, that which has been used by the Department of Agriculture be accepted as correct, the figures on distribution (*see* supposition 1 in the last table) exceed those on supply by 171,000,000 bushels. The figures on exportation must be regarded as accurate, and if we also consider those in relation to wheat consumed for seed to be correct, we shall, on this supposition as to the consumption for food, be driven to the conclusion that the crop estimates for the five years under consideration have fallen short of the actual production during the same period by 171,000,000 bushels, to which something must be added for losses and for uses other than for human food. If we should add 16,000,000 bushels to cover such items, making the total deficiency 187,000,000 bushels, this would raise the total production for the five years from 2,413,000,000 to 2,600,000,000 bushels, and would make the deficiency of the estimates 7·2 per cent.

If the error in respect to area were assumed to be 4 per cent, the corresponding error in the rate of yield necessary to account for the results indicated above would be a fraction over 3·3 per cent.* If the consumption has been at all overestimated, the percentage for underestimate of production must be correspondingly reduced; and if the true consumption has been as low as the Atkinson estimate makes it, the estimates of production have either been almost exactly correct (*see*

* It may seem at first sight that if an error of 7·2 were distributed between area and rate of yield in such a manner as to assign an error of 4 per cent to the former, the error in the latter would be just 3·2 per cent; but an analysis of the problem will at once show that this is not the case.

supposition 2 in the last table) or have been about 2 per cent too high (*see* supposition 3).

It is claimed by some agricultural and commercial papers that to the visible supply should be added the commercial stocks of wheat in California and those in small elevators and elsewhere in other parts of the country; but these are probably about balanced by stocks on hand five years ago in corresponding situations, and consequently need not be taken into account.

Let us see now how these several estimates in regard to the average consumption of wheat for food fit in with the other items of supply and distribution for a longer period. The years beginning with March 1, can not conveniently be used for this purpose, and it will be necessary to take the fiscal years beginning July 1 in connection with the crops harvested near the beginning of such fiscal years. If we take the ten years beginning July 1, 1879, and ending June 30, 1889, they will overlap the five-year period already considered by only four months—that is, by the time from March 1 to June 30, inclusive.

Statistics as to the stock on hand at the beginning of this decade can not readily be obtained, if at all; but the difference between the stocks at its beginning and end can not have been large enough to affect the results in any material degree where so long a period is in question. Taking, then, the production on the one side, and exports,* seed, and consumption for food on the other, we get in millions of bushels the following results:

	A. Consumption estimated at $4\frac{2}{3}$ bushels per capita.		B. Consumption estimated at $4\frac{2}{3}$ bushels per adult.*		C. Consumption estimated at $4\frac{1}{2}$ bushels per adult.*	
Production, 1879–1888	....	4,455	....	4,455	....	4,455
Net exports for ten fiscal years beginning July 1, 1879	1,337		1,337		1,337	
Used for seed	538		538		538	
Used for food	2,566		2,254		2,174	
Total exports, seed and food	....	4,441	....	4,129	....	4,049
Excess of supply over distribution	....	14	....	326	....	406
Average annual excess	....	1·4	....	32·6	....	40·6

* Adults being reckoned as already explained

It will be seen that taking consumption for food at $4\frac{2}{3}$ bushels per capita there is an almost exact correspondence for this decade between production and distribution, the average annual excess of the former over the latter being only 1,400,000 bushels. This may, perhaps, be insufficient to cover other forms of consumption and losses by fire, flood, etc., but the excess on the basis of the two other estimates for food consumption (32,600,000 bushels per annum in the one case and 40,600,000 in the other) would seem to err far more widely in the opposite direction. This, of course, assumes that the estimates of production for these years are substantially correct.

In considering the preceding decade (that comprising the crop years from 1869 to 1878 and the ten fiscal years extending from July 1, 1869, to June 30, 1879), the consumption for seed from 1869 to 1875 is estimated on the basis of the area for those years, there being no estimates

* These are the net exports obtained by deducting the imports from the exports of domestic and foreign, but they do not differ materially from the exports of domestic.

of seed consumption on record in the Department reports for this period. The figures for that decade are given below:

	A. Consumption estimated at $4\frac{2}{3}$ bushels per capita.		B. Consumption estimated at $4\frac{2}{3}$ bushels per adult.*		C. Consumption estimated at $4\frac{1}{2}$ bushels per adult.*	
Production, 1869-1878		2,932		2,932		2,932
Net exports for ten fiscal years beginning July 1, 1869	728		728		728	
Used for seed	367		367		367	
Used for food	2,004		1,761		1,698	
Total exports, seed and food		3,099		2,856		2,793
Excess of supply over distribution				76		139
Excess of distribution over supply		167				
Average annual excess of supply				7·6		13·9
Average annual deficiency of supply		16·7				

*Adults being reckoned as already explained.

It thus appears that if we put the consumption for food at $4\frac{2}{3}$ bushels per capita, the crops for the ten years do not suffice to cover the three main elements of distribution, but fall short of doing so by an aggregate of 167,000,000 bushels, or an average of 16,700,000 bushels a year, besides leaving nothing for losses and for uses other than for seed and food. On the hypothesis that consumption for food amounted to $4\frac{2}{3}$ bushels per adult, the supply exceeded these main elements of distribution by 76,000,000 bushels, or an average of 7,600,000 bushels a year. If losses and other minor elements of distribution were deducted from this surplus, it would be reduced within still narrower limits. On the hypothesis that the consumption for food amounts to only $4\frac{1}{2}$ bushels per adult the surplus amounts to 130,000,000 bushels, or an average of 13,900,000 a year, and would still be quite large if a reasonable allowance were made for losses, etc.

We see, then, that for the period 1869–1878 the estimate of $4\frac{2}{3}$ bushels of wheat per adult is the one that accords most closely with the figures on production and on other elements of distribution.

For the period 1879–1888 it is the estimate of $4\frac{2}{3}$ bushels per capita that best accords with the other official figures on production and distribution, and the correspondence is extremely close.

On the other hand, for the five-year period 1889–1893 the estimate of $4\frac{2}{3}$ bushels per adult again takes the first place in respect to closeness of correspondence with the other items of the account.

It is to be noted that no one of the three food estimates considered is presented as a mere derivative from the other elements of supply and distribution. There is reason to believe that some commercial estimates are obtained by simply deducting the sum of the exports and seed for a series of years from the estimated production for the same period and dividing the remainder by the estimated population. Such an estimate, if correct, would give the total consumption for all purposes other than seed; but its correctness is, of course, dependent on that of the other elements used in the computation, and it has, therefore, no independent value as an aid in testing the accuracy of the figures on production, since these form the chief one of the other elements in question.

If we assume the substantial correctness of the crop reports in all three of the periods considered, the examination of the middle period gives us results tending strongly to establish the accuracy of the estimate of $4\frac{2}{3}$ bushels per capita as the quantity consumed for food, while

the results of our examination of the first and third would tend to prove that the estimate of $4\frac{2}{3}$ bushels per adult is much nearer to the truth.

On the other hand, if we should assume the correctness of the first of these estimates as to food consumption, the crop estimates of 1879–1888 would be strikingly corroborated, while those of 1869–1878 and 1889–1893 would be proved too low. But if we should assume the accuracy of the second estimate as to food consumption, the case would be reversed, the crop estimates for 1869–1878 and 1889–1893 being in that case substantially confirmed, while those for 1879–1888 are found much too high.

It would certainly be an advantage to have an independent estimate of food consumption sufficiently exact and certain to serve as a trustworthy test for the accuracy of the statistics of production, but the facts disclosed by our examination of the figures for the last twenty-five years hardly indicate that this desideratum has as yet been attained. The evidence is not on record that there has at any time been an inquiry as to the quantity of wheat consumed for food comparable in respect to its extent and fullness with that which takes place every year in respect to production; and for the present it would seem that the statistics on the latter subject must stand or fall on their own merit.

THE WHEAT CROP OF THE WORLD.

The following table shows the world's production of wheat by countries for the year 1893 as compared with that of 1892 and 1891. The latest official returns for the different countries were used wherever available. In certain cases these official statements are preliminary and may be changed by the corrected estimates. There is little doubt, for instance, that the estimates for Germany and Russia will be reduced by the final returns. Many countries make no official estimate of wheat production, and in such cases the most trustworthy commercial estimates were taken. The bushel used is the Winchester bushel, which has a capacity of 2,150·42 cubic inches. Where quantities were given by weight they were reduced to bushels under the assumption that 60 pounds of wheat make a Winchester bushel. The crops of the countries in the Southern Hemisphere are those gathered in November and December, 1892, and in January and February, 1893.

In North America the total production of wheat in 1893 was 447,479,000 bushels, a decrease of nearly 127,000,000 as compared with the preceding year and of 237,000,000 as compared with 1891. The large extension of the wheat area in Argentina brought up the production of South America from 51,000,000 in 1892 to 82,000,000 in 1893, an increase of 61 per cent. Europe produced 27,000,000 bushels more in 1893 than in the preceding year. Asia's share of the world's wheat production was 346,000,000 bushels as against 290,000,000 in 1892 and 345,000,000 in 1891. Africa's crop was 35,500,000, an increase of 1,000,000 bushels over 1892. Australasia's outturn stood at 41,000,000 bushels as compared with 36,000,000 in 1892 and 33,000,000 in 1891. The total world's crop of wheat for 1893 is estimated at 2,385,360,000 bushels, which is less by 7,000,000 than the crop of 1892 and exceeds the crop of 1891 by about 21,000,000 bushels.

The wheat crop of the world.

Countries.	1891.	1892.	1893.
	Bushels.	*Bushels.*	*Bushels.*
United States	611, 780, 000	515, 949, 000	396, 132, 000
Canada:			
Ontario	32, 584, 000	28, 783, 000	21, 731, 000
Manitoba	23, 196, 000	14, 454, 000	15, 616, 000
Rest of Canada	4, 941, 000	4, 945, 000	4, 000, 000
Total Canada	60, 721, 000	48, 182, 000	41, 347, 000
Mexico	12, 000, 000	10, 000, 000	10, 000, 000
Total North America	684, 501, 000	574, 131, 000	447, 479, 000
Argentina	33, 000, 000	30, 000, 000	56, 750, 000
Chile	14, 000, 000	18, 000, 000	19, 200, 000
Uruguay	3, 000, 000	3, 292, 000	5, 694, 000
Total South America	50, 000, 000	51, 292, 000	81, 644, 000
Austria	41, 071, 000	50, 170, 000	42, 600, 000
Hungary	139, 278, 000	142, 013, 000	158, 000, 000
Croatia and Slavonia	7, 000, 000	7, 984, 000	7, 315, 000
Bosnia and Herzegovina	1, 800, 000	2, 000, 000	2, 000, 000
Belgium	15, 560, 000	20, 748, 000	17, 500, 000
Bulgaria	40, 902, 000	40, 441, 000	26, 941, 000
Denmark	4, 666, 000	5, 000, 000	5, 000, 000
France	220, 353, 000	310, 814, 000	277, 857, 000
Germany	85, 750, 000	116, 215, 000	119, 748, 000
Great Britain	74, 401, 000	60, 407, 000	50, 800, 000
Ireland	2, 615, 000	2, 214, 000	1, 666, 000
Greece	5, 675, 000	4, 000, 000	6, 500, 000
Italy	141, 456, 000	115, 676, 000	119, 695, 000
Netherlands	3, 504, 000	6, 200, 000	5, 500, 000
Portugal	7, 000, 000	6, 100, 000	5, 000, 000
Roumania	45, 672, 000	60, 253, 000	59, 588, 000
Russia	168, 846, 000	241, 579, 000	321, 497, 000
Poland	12, 681, 000	24, 440, 000	21, 554, 000
The Caucasus	74, 000, 000	71, 266, 000	60, 000, 000
Servia	5, 000, 000	5, 500, 000	6, 000, 000
Spain	71, 349, 000	78, 396, 000	86, 000, 000
Sweden	4, 341, 000	4, 560, 000	4, 006, 000
Norway	400, 000	400, 000	400, 000
Switzerland	3, 300, 000	3, 301, 000	2, 500, 000
Turkey in Europe	30, 000, 000	21, 756, 000	21, 000, 000
Cyprus	2, 000, 000	2, 000, 000	2, 000, 000
Total Europe	1, 208, 620, 000	1, 406, 933, 000	1, 433, 666, 000
India	256, 704, 000	206, 640, 000	266, 896, 000
Asiatic Turkey	49, 000, 000	49, 000, 000	45, 000, 000
Persia	20, 630, 000	18, 567, 000	19, 000, 000
Japan	18, 277, 000	15, 737, 000	15, 000, 000
Total Asia	344, 611, 000	289, 944, 000	345, 896, 000
Algeria	26, 184, 000	19, 399, 000	19, 000, 000
Cape Colony	2, 046, 000	2, 813, 000	4, 014, 000
Egypt	11, 140, 000	8, 252, 000	10, 000, 000
Tunis	4, 256, 000	4, 000, 000	2, 500, 000
Total Africa	43, 626, 000	34, 464, 000	35, 514, 000
New South Wales	3, 649, 000	3, 964, 000	6, 817, 000
Victoria	12, 751, 000	13, 679, 000	14, 815, 000
South Australia	9, 399, 000	6, 436, 000	9, 240, 000
Western Australia	465, 000	296, 000	429, 000
Tasmania	643, 000	938, 000	1, 019, 000
New Zealand	5, 724, 000	10, 258, 000	8, 378, 000
Queensland	208, 000	392, 000	463, 000
Total Australasia	32, 839, 000	35, 963, 000	41, 161, 000
RECAPITULATION BY CONTINENTS:			
North America	684, 501, 000	574, 131, 000	447, 479, 000
South America	50, 000, 000	51, 292, 000	81, 644, 000
Europe	1, 208, 620, 000	1, 406, 933, 000	1, 433, 666, 000
Asia	344, 611, 000	289, 944, 000	345, 896, 000
Africa	43, 626, 000	34, 464, 000	35, 514, 000
Australasia	32, 839, 000	35, 963, 000	41, 161, 000
Grand total	2, 364, 197, 000	2, 392, 727, 000	2, 385, 360, 000

WHOLESALE PRICES OF AGRICULTURAL PRODUCTS.

The quotations given below have, for the most part, been furnished by the secretaries of the boards of trade of the different cities named:

Wholesale prices of principal agricultural products at leading cities in all sections of the United States.

Date.	Boston.	New York.	Atlanta.	New Orleans.	Cincinnati.
CORN (per bushel).					
	Steamer mixed.	*No. 2 mixed.*	*White.*	*No. 2 mixed.*	*No. 2 mixed.*
Dec. 1, 1892	\$0.54 to \$0.55	$\$0.51\frac{1}{2}$ to $\$0.51\frac{7}{8}$	\$0.58	\$0.51	\$0.43
Jan. 3, 1893	.51 to $.51\frac{1}{2}$	$.50\frac{1}{4}$ to $.50\frac{1}{2}$	.58	\$0.48 to .49	$\$0.40\frac{1}{2}$ to .41
Feb. 1, 1893	.54	$.54\frac{3}{4}$ to .55	.60	.52	.42 to $.42\frac{1}{2}$
Dec. 1, 1893	$.46\frac{1}{2}$	$.44\frac{3}{4}$ to $.45\frac{1}{4}$	.55	.49	.40
Jan. 2, 1894	$.45\frac{1}{2}$	$.41\frac{7}{8}$ to $.42\frac{1}{4}$	.53	.47 to .48	.37
Feb. 1, 1894	.46	$.42\frac{3}{8}$ to $.42\frac{7}{8}$	.55	$.45\frac{1}{2}$ to .46	$.37\frac{1}{2}$
WHEAT (per bushel).					
		No. 2 red.			*No. 2 red.*
Dec. 1, 1892	......	$\$0.76\frac{5}{8}$ to $\$0.78\frac{1}{8}$	......	......	\$0.70
Jan. 3, 1893	......	$.79\frac{3}{4}$ to .81	......	......	.70
Feb. 1, 1893	......	$.80\frac{1}{8}$ to $.80\frac{3}{4}$	......	......	.71
Dec. 1, 1893	......	$.68\frac{1}{8}$ to $.69\frac{1}{4}$	......	......	\$0.59 to .60
Jan. 2, 1894	......	$.66\frac{5}{8}$ to $.67\frac{5}{8}$	......	......	.59 to $.59\frac{1}{2}$
Feb. 1, 1894	......	$.67\frac{3}{8}$ to $.67\frac{3}{4}$	......	......	.59 to $.59\frac{1}{2}$
OATS (per bushel).					
	No. 2 white.	*No. 2 mixed.*	*No. 2 mixed.*	*No. 2.*	*No. 2 mixed.*
Dec. 1, 1892	\$0.43	$\$0.36\frac{1}{2}$	\$0.44	\$0.41	$\$0.35\frac{1}{2}$ to \$0.36
Jan. 3, 1893	.41	$\$0.36\frac{1}{2}$ to $.36\frac{3}{4}$	.45	\$0.40 to .41	$.34\frac{1}{2}$ to $.34\frac{3}{4}$
Feb. 1, 1893	.43	$.38\frac{1}{4}$	.48	.40 to .41	.34 to $.34\frac{1}{2}$
Dec. 1, 1893	.38	$.34\frac{3}{8}$ to $.34\frac{1}{2}$	.43	.38	$.31\frac{1}{2}$ to .32
Jan. 2, 1894	\$0.36 to $.36\frac{1}{2}$	$.33\frac{3}{4}$	.44	.38	.31
Feb. 1, 1894	.38	.34	.41	$.37\frac{1}{2}$ to .38	$.31\frac{1}{4}$
BARLEY (per bushel).					
	Six rowed state.	*Two-rowed state.*			*No. 2 spring.*
Dec. 1, 1892	......	\$0.65 to \$0.68	......	......	\$0.65 to \$0.67
Jan. 3, 1893	\$0.70 to \$0.75	.65 to .67	......	......	.65 to .67
Feb. 1, 1893	.70 to .75	.65 to .67	......	......	.65 to .67
Dec. 1, 1893	.70 to .75	.63 to .64	......	......	.58 to .60
Jan. 2, 1894	.70 to .75	.63	......	......	.58 to .60
Feb. 1, 1894	.70 to .75	.63 to .64	......	......	.58 to .60
HAY (per ton).					
	Fair to good.	*Prime timothy.*		*Prime.*	*No. 1 timothy.*
Dec. 1, 1892	\$16.00 to \$17.00	\$18.00	\$18.00	\$13.00 to \$14.50	\$10.50 to \$11.00
Jan. 3, 1893	15.50 to 16.50	17.00	19.00	14.00 to 15.50	11.00 to 11.50
Feb. 1, 1893	15.00 to 16.00	\$17.00 to 18.00	19.00	15.00 to 16.00	12.50 to 13.50
Dec. 1, 1893	15.00 to 16.50	17.00	18.00	14.50 to 16.00	11.00 to 12.00
Jan. 2, 1894	15.50 to 16.50	17.00 to 18.00	17.00	16.50 to 17.00	11.50 to 12.00
Feb. 1, 1894	15.50 to 16.50	17.00	18.00	14.50 to 16.00	11.50 to 12.00
COTTON (per pound).					
		Middling up.		*Middling.*	*Middling.*
Dec. 1, 1892	......	$\$0.09\frac{3}{4}$	\$0.09	$\$0.09\frac{9}{16}$	\$0.10
Jan. 3, 1893	......	$.09\frac{7}{8}$	$.09\frac{3}{8}$	$.09\frac{1}{2}$	.10
Feb. 1, 1893	......	$.09\frac{7}{16}$	.09	$.09\frac{1}{4}$	$.09\frac{5}{8}$
Dec. 1, 1893	......	$.08\frac{1}{16}$	$.07\frac{1}{4}$	$.07\frac{9}{16}$	$.07\frac{7}{8}$
Jan. 2, 1894	......	$.07\frac{15}{16}$	$.07\frac{1}{8}$	$.07\frac{5}{16}$	$.07\frac{3}{8}$
Feb. 1, 1894	......	.08	$.07\frac{1}{4}$	$.07\frac{7}{16}$	$.07\frac{3}{4}$
BUTTER (per pound).					
	Extra creamery.	*State dairy, best.*			*Fancy creamery.*
Dec. 1, 1892	\$0.29	\$0.26	......	......	\$0.32
Jan. 3, 1893	\$0.30 to .31	.27	......	......	.32
Feb. 1, 1893	.30	.28	......	......	.30
Dec. 1, 1893	.28	.26	......	......	.29
Jan. 2, 1894	.27 to .28	.25	......	......	\$0.28 to .29
Feb. 1, 1894	.26 to .27	\$0.20 to .22	......	......	.23
EGGS (per dozen).					
	Eastern extra.	*State.*			
Dec. 1, 1892	\$0.28	\$0.29	\$0.20	......	\$0.22
Jan. 3, 1893	\$0.28 to .32	.31	$.22\frac{1}{2}$	......	.24
Feb. 1, 1893	.36	\$0.34 to .35	.25	......	.33
Dec. 1, 1893	.27 to .28	.26 to .28	.20	......	.21
Jan. 2, 1894	.26	.24 to .26	.22	......	\$0.19 to .20
Feb. 1, 1894	.18	.16 to .17	.21	......	.12 to .13

Wholesale prices of principal agricultural products at leading cities in all sections of the United States—Continued.

CORN (per bushel).

Date.	Chicago.	Minneapolis.	St. Paul.	St. Louis.	San Francisco.
	No. 2.	*No. 3 yellow.*	*No. 3 yellow.*	*No. 2.*	*No. 1 white.**
Dec. 1, 1892	$0.42 to $0.42½	....	$0.39 to $0.40	$0.38½ to $0.38⅝	$1.12½ to $1.15
Jan. 3, 1893	.40½ .40⅝	$0.36	.37 .38	.37¼	1.07½ 1.10
Feb. 1, 1893	.44 .44⅜	.40	.40 .41	.40 .40¼	1.02½ 1.05
Dec. 1, 1893	.34⅞ .35⅛	$0.31¾ to .32	.33 .34	.34	.90 .92½
Jan. 2, 1894	.34½ .35¼	.32	.32 .33	.31½ .31⅝	.90 .91¼
Feb. 1, 1894	.35⅛ .35⅜	.32¼	.32½ .33	.33½ .33⅞	.90 .91¼

WHEAT (per bushel).

Date.	Chicago.	Minneapolis.	St. Paul.	St. Louis.	San Francisco.
	No. 2 red winter.	*No. 1 northern.*	*No. 2 northern.*	*No. 2 red winter.*	*No. 1 white.**
Dec. 1, 1892	$0.71¼ to $0.71¾	$0.67⅛	$0.62 to $0.65	$0.68¾	$1.26¼ to $1.27½
Jan. 3, 1893	.72 .72½	.66	.61 .62	$0.67⅞ to .68	1.27½
Feb. 1, 1893	.73¾ .74	.68	.61 .65	.68½ .68¾	1.27½ 1.28¾
Dec. 1, 1893	.63 .63½	.59¼	.57 .58	.59⅜	1.02½ 1.03¾
Jan. 2, 1894	.60¼ .60⅞	.59¾	.58 .59	.56¾ .56⅞	1.02½ 1.03¾
Feb. 1, 1894	.60¼ .60⅝	.60	.60 .60½	.56½ .56¾	.98¾ 1.00

OATS (per bushel).

Date.	Chicago.	Minneapolis.	St. Paul.	St. Louis.	San Francisco.
	No. 2.	*No. 3 mixed.*	*No. 2 white.*	*No. 2.*	*No. 1.**
Dec. 1, 1892	$0.31½	$0.31¼	$0.31½ to $0.32	$0.31	$1.27½ to $1.30
Jan. 3, 1893	$0.30½ to .31	$0.28½ to .29½	.30 .30½	$0.31½ to .32	1.32½ 1.35
Feb. 1, 1893	.32	.32½	.32 .32½	.31	1.35 1.37½
Dec. 1, 1893	.28¾	.27	.27 27½	.27¾	1.05 1.07½
Jan. 2, 1894	.29 29½	.26 .27	.28 28½	.27¼ .27½	1.00 1.05
Feb. 1, 1894	.28 28¼	.26½	.28	.28¾	1.15 1.17½

BARLEY (per bushel).

Date.	Chicago.	Minneapolis.	St. Paul.	St. Louis.	San Francisco.
	Fair to choice.	*No. 3.*	*No. 2.*	*Choice.*	*No. 1 chevalier.**
Dec. 1, 1892	$0.50 to $0.58	$0.33 to $0.38	$0.50 to $0.55	$0.62 to $0.63	$1.12 to $1.15
Jan. 3, 1893	.52 .65	.39 .40	.50 .55	.60	1.15 1.17½
Feb. 1, 1893	.42 .65	....	.50 .55	.60	1.15 1.17½
Dec. 1, 1893	.46 .52	.39 .40	....	.57	1.15 1.17½
Jan. 2, 1894	.42 .59	.38	....	.55	1.15 1.17½
Feb. 1, 1894	.44 .54	....	.50	.52 .54	....

HAY (per ton).

Date.	Chicago.	Minneapolis.	St. Paul.	St. Louis.	San Francisco.
	No. 1 timothy.	*Wild.*	*Timothy.*	*Timothy, fancy.*	*No. 1 barley.**
Dec. 1, 1892	$11.00 to $12.00	$8.00 to $8.25	$8.00 to $9.50	$12.50	$8.00 to $9.00
Jan. 3, 1893	10.50 11.00	7.50	7.00 8.00	13.00	8.00 9.00
Feb. 1, 1893	11.00 11.50	7.00	8.50 9.00	14.00	7.00 8.00
Dec. 1, 1893	10.00 10.50	6.00 6.50	7.50 8.50	12.50	10.00 11.00
Jan. 2, 1894	10.00 10.50	4.00 5.00	7.00 8.00	12.00	10.00 11.00
Feb. 1, 1894	9.00 10.00	3.50 4.00	7.00 8.00	12.00	9.00 11.00

COTTON (per pound).

Date.	Chicago.	Minneapolis.	St. Paul.	St. Louis.	San Francisco.
				Middling.	
Dec. 1, 1892	....	....	....	$0.10	....
Jan. 3, 1893	....	....	....	$.09\frac{13}{16}$	....
Feb. 1, 1893	....	....	....	$.09\frac{7}{16}$	....
Dec. 1, 1893	....	....	....	$.07\frac{9}{16}$	....
Jan. 2, 1894	....	....	....	$.07\frac{5}{16}$	....
Feb. 1, 1894	....	....	....	$.07\frac{9}{16}$	....

BUTTER (per pound).

Date.	Chicago.	Minneapolis.	St. Paul.	St. Louis.	San Francisco.
			No. 1 creamery.	*Creamery.*	*Good to choice.*
Dec. 1, 1892	....	....	$0.25 to $0.26	$0.27 to $0.31	$0.24 to $0.26
Jan. 3, 1893	....	....	.25 .26	.28 .32	.25 .27
Feb. 1, 1893	....	....	.25 .26	.24 .30	.20 .24
Dec. 1, 1893	....	....	.22 .25	.24 .28	.20 .26
Jan. 2, 1894	....	....	.22 .24	.24 .28	.20 .22
Feb. 1, 1894	....	....	.22 .23	.22 .28	.20 .22

EGGS (per dozen).

Date.	Chicago.	Minneapolis.	St. Paul.	St. Louis.	San Francisco.
					Choice.
Dec. 1, 1892	$0.20 to $0.22	....	$0.21 to $0.22	$0.22	$0.37½ to $0.40
Jan. 3, 1892	.24 .27	....	.23 .24	.22½	.35 .37
Feb. 1, 1893	.29 .30	....	.30 .31	.27½	.28 .30
Dec. 1, 1893	.22½ .23	....	.21 .22	.21	.36 .42
Jan. 2, 1894	.20 .21	....	.21½ .22	.18½	.27 .30
Feb 1 1894	.13 .13½	....	.15 .16	.11¾	.21 .23

* Per cental.

Wholesale prices of principal agricultural products at leading cities in all sections of the United States—Continued.

TOBACCO.

Date.	New York.		St. Louis.				Louisville.	
	Pennsylvania seed leaf.		Missouri Burley leaf, medium to good.		Old style, medium to good.		Burley leaf.	
	Per pound.		*Per pound.*		*Per pound.*		*Per pound.*	
Dec. 1, 1892	$0.11 to	$0.15	$0.10 to	$0.13	$1.06½ to	$0.08½	$0.09 to	$0.10
Jan. 3, 1893	*a*.11	.15	.10	.13	.06½	.08½	.10	.12
Feb. 1, 1893	*b*.11	.15	.10	.15	.06½	.08½	.10	.12
Dec. 1, 1893	*c*.08	.10	.08½	.12	.06½	.08	.09	.10
Jan. 2, 1894	*d*.08	.10	.08	.10	.07	.08½	.09	.10
Feb. 1, 1894	*e*.08	.10	.08	.10	.07	.08½	.09	.10

a Prices for January 11.
b Prices for February 8.
c Prices for December 7.
d Prices for January 8.
e Prices for February 7.

EXPENSE OF RAISING WHEAT AND CORN.

In consequence of numerous inquiries relative to the cost of raising our principal cereals coming from both this country and abroad, a careful investigation has been made by the Department of Agriculture as to the cost of raising the staple products, corn and wheat. In view of the present low prices of wheat prevailing throughout the world, the results of this investigation are of unusual economic importance, and it is believed that the time has come to sound a note of warning against the exclusive dependence on the cereal crops, and in favor of a more diversified culture. With wheat selling at 57 cents and corn at 36 cents a bushel in Chicago, it is impossible to escape the conclusion that a rotation of crops would be more profitable to our farmers than a persistence in exclusive wheat-growing.

The subjoined tabular statement will show that his time and the interest on the money invested in his land have been included in the actual expense incurred by the farmer in the production of his crops. The following items have been considered in making an estimate of the total cost of raising wheat: Rent of land, manure, seed, and labor, the last of which is subdivided into preparation of soil, sowing, harvesting, thrashing, housing, and marketing. In the case of corn, the labor consists of preparing the soil, planting, cultivating, gathering, housing, and marketing.

Cost per acre of raising wheat and corn.

	Wheat.	Corn.
Rent of land	$2.81	$3.03
Manure	2.16	1.86
Preparing ground	1.87	1.62
Seed	.96	....
Sowing or planting	.37	.42
Cultivating	....	1.80
Harvesting or gathering	1.19	1.22
Thrashing	1.20	....
Housing	.37	.56
Marketing	.76	1.26
Total	11.69	11.71

In the Statistician's report for December, 1893, the average farm value of wheat and corn produced per acre was stated as follows: Wheat, \$6.16; corn, \$8.21. This would show on the face of it a virtual loss to the farmer of \$5.53 per acre of wheat and \$3.50 per acre of corn for the year 1893. It must be remembered, however, that besides the production of the grain the farmer has the straw of the wheat and the stalks of corn, which have in some sections of the country a feeding value of about \$5 per acre, and that while the cost of production was about normal the price per bushel of wheat was unprecedentedly low and that of corn much below the average.

The fact that the farmer is allowed average rent for his land, and wages for his labor, in the above calculation, should also be taken into consideration in computing his profits.

The results have been derived from individual estimates made by over 25,000 practical farmers in the case of wheat and over 28,000 in the case of corn. A second set of replies was received from over 4,000 experts, i. e., the graduates of various agricultural colleges now engaged in farming, and this result tallies very closely with that obtained from the general inquiry.

The following statement will show in detail the figures of cost of producing corn and wheat by States and sections:

Estimated cost of the principal items and total cost in the production of wheat and corn by States and sections per acre for 1893.

[Consolidated from returns from nearly 30,000 leading farmers scattered throughout the United States.]

States and sections.	Wheat.										
	Rent of land per acre.	Manure.	Preparing ground (plowing, harrowing, etc.).	Seed.	Sowing.	Harvesting.	Thrashing.	Housing.	Marketing.	Total.	Amount sown per acre.
											Bush.
Maine	$3.43	$4.96	$3.39	$2.30	$0.44	$2.21	$2.28	$0.79	$1.21	$21.01	2
New Hampshire	3.74	5.59	3.73	2.12	.71	2.49	2.31	.80	1.48	22.97	1·7
Vermont	3.51	3.78	3.17	2.09	.51	2.24	1.80	.68	1.24	19.02	2·3
Massachusetts	4.08	5.43	3.83	1.80	.72	2.58	2.63	.96	1.79	23.82	2
Connecticut	6.31	4.81	4.09	1.50	.51	2.83	2.72	.83	2.74	26.34	1·8
New England	3.52	4.41	3.32	2.16	.52	2.27	2.02	.73	1.27	20.22	2·1
New York	4.56	5.36	3.01	1.64	.49	1.49	1.44	.60	.93	19.52	1·9
New Jersey	4.61	6.72	2.50	1.53	.53	1.36	1.58	.66	.80	20.29	1·8
Pennsylvania	3.70	5.01	2.77	1.32	.46	1.39	1.42	.64	.89	17.60	2
Delaware	4.67	4.15	2.40	1.10	.57	1.11	1.30	.59	.70	16.59	2
Middle	4.01	5.16	2.79	1.40	.48	1.40	1.43	.63	.88	18.18	2
Maryland	3.64	3.48	2.42	1.11	.49	1.17	1.35	.58	1.04	15.28	1·8
Virginia	2.54	2.83	1.92	1.03	.47	.93	.93	.30	.92	11.87	1·3
North Carolina	2.68	1.77	1.54	.91	.42	.75	.73	.34	.71	9.85	1
South Carolina	2.46	2.12	1.20	1.05	.26	.71	.89	.33	.61	9.66	1
Georgia	2.44	2.13	1.28	.94	.37	.74	.88	.30	.67	9.75	1
Florida	3.19	1.83	2.81	1.16	.29	1.34	.72	1.08	1.03	13.45	1·2
Alabama	2.35	1.96	1.45	.94	.90	.79	.96	.34	.76	10.45	1·1
Mississippi	2.51	2.07	1.69	.98	.52	1.03	1.14	.53	1.01	11.48	1·1
Louisiana	2.23	2.42	1.77	1.23	.48	1.31	1.32	.51	1.25	12.52	1·7
Texas	3.13	1.47	1.59	.79	.39	1.19	1.14	.29	.78	10.77	1·2
Arkansas	2.60	1.56	1.42	.84	.33	.93	.85	.28	.82	9.63	1·2
Tennessee	2.66	1.24	1.60	.80	.35	.97	.88	.23	.63	9.36	1·1
Southern	2.79	2.09	1.71	.93	.41	.94	.95	.33	.79	10.94	1·2
West Virginia	3.27	1.92	2.30	1.12	.47	1.18	1.02	.41	.89	12.58	1·4
Kentucky	3.31	1.66	1.67	.91	.39	1.30	1.10	.30	.70	11.34	1·5
Ohio	3.72	2.08	2.46	1.08	.45	1.29	1.35	.46	.73	13.62	1·5
Michigan	3.05	2.86	2.73	1.21	.35	1.36	1.11	.34	.82	13.83	1·5
Indiana	3.55	2.02	2.03	.91	.40	1.13	1.33	.38	.64	12.39	1·3
Illinois	3.68	1.76	1.58	.96	.29	1.13	1.23	.28	.54	11.45	1·4
Wisconsin	2.91	3.09	1.89	1.19	.38	1.15	1.11	.36	.85	12.93	1·7
Minnesota	2.26	2.35	1.65	.97	.38	1.22	1.02	.28	.61	10.74	1·5
Iowa	2.73	1.40	1.37	1.06	.24	1.10	1.06	.24	.54	9.74	1·7
Missouri	2.61	1.52	1.52	.79	.30	1.15	1.08	.26	.68	9.91	1·4
Kansas	2.10	1.27	1.40	.66	.32	1.23	1.18	.30	.58	9.04	·9
Nebraska	2.17	1.63	1.39	.77	.28	1.11	1.07	.26	.54	9.22	1·5
South Dakota	1.52	1.42	1.55	.82	.31	1.12	.97	.25	.61	8.57	1·4
North Dakota	1.63	1.49	1.69	.91	.42	1.00	1.42	.31	.75	9.62	1·3
Western	2.62	1.85	1.80	.92	.36	1.18	1.18	.32	.66	10.89	1·4
Colorado	3.08	2.14	2.05	.88	.39	1.90	1.39	.52	1.43	13.78	1·0
Utah	5.24	4.44	2.60	1.04	.36	1.81	2.04	.65	1.54	19.72	1·5
Idaho	3.47	1.35	2.31	.95	.35	1.53	1.63	.59	1.95	14.13	1·5
Mountain region	3.88	2.70	2.29	.95	.37	1.78	1.66	.58	1.59	15.80	1·3
Washington	4.17	3.89	2.18	.90	.36	1.70	1.81	.69	1.37	17.07	1·2
Oregon	3.21	2.61	2.14	.92	.31	1.25	1.36	.50	1.20	13.50	1·4
California	3.17	2.38	1.96	1.08	.31	1.40	1.35	.54	1.32	13.51	1·4
Pacific	3.31	2.62	2.02	1.03	.32	1.41	1.41	.55	1.31	13.98	1·4
Total	2.81	2.16	1.87	.96	.37	1.19	1.20	.37	.76	11.69	1·4

Estimated cost of the principal items and total cost in the production of wheat and corn by States and sections per acre for 1893—Continued.

States and sections.	Corn.								
	Rent of land per acre.	Manure.	Preparing ground (plowing, harrowing, etc.).	Planting.	Cultivating.	Gathering.	Housing.	Marketing.	Total.
Maine	$3.69	$5.10	$4.06	$1.73	$3.27	$3.49	$2.22	$2.25	$25.81
New Hampshire	5.01	5.49	4.73	1.63	3.77	4.69	2.45	2.71	30.48
Vermont	3.98	1.12	3.45	1.11	2.72	4.58	1.66	1.98	20.60
Massachusetts	5.40	6.65	4.30	1.56	3.72	4.92	2.48	2.40	31.43
Connecticut	5.13	5.88	4.63	1.72	3.99	5.25	2.08	2.92	31.60
New England	4.76	4.69	4.21	1.51	3.50	4.77	2.13	2.46	28.03
New York	4.76	6.41	3.17	.88	2.39	3.58	1.27	1.61	24.07
New Jersey	4.31	5.78	2.74	.74	2.26	2.48	.86	1.40	20.57
Pennsylvania	3.84	6.29	2.99	.69	2.64	2.54	.97	1.52	21.48
Delaware	4.54	3.26	2 37	.69	2.22	1.73	.61	1.10	16.52
Middle	4.17	5.99	2.95	.74	2.50	2.70	.99	1.49	21.53
Maryland	3.82	3.12	2.52	.62	1.91	1.96	1.15	2.05	17.15
Virginia	2.90	2.22	1.99	.53	1.99	1.11	.68	1.50	12.92
North Carolina	3.54	1.90	1.49	.49	2.31	.68	.49	1.01	11.91
South Carolina	2.46	1.97	1.22	.36	2.07	.58	.39	.99	10.04
Georgia	2.37	1.76	1.26	.49	2.17	.63	.43	1.03	10.14
Florida	2.29	2.16	2.02	.70	2.82	.65	.60	1.21	12.45
Alabama	2.44	1.83	1.39	.62	2.45	.68	.51	1.15	11.07
Mississippi	3.06	2.15	1.42	.78	2.49	.80	.58	1.48	12.76
Louisiana	4.12	2.02	1.66	.55	2.37	.82	.61	1.42	13.57
Texas	3.08	1.88	1.61	.47	1.93	.81	.47	1.45	11.70
Arkansas	3.07	1.75	1.44	.60	2.58	.91	.49	1.59	12.43
Tennessee	3.35	1.46	1.52	.45	2.23	.83	.52	1.42	11.78
Southern	3.00	1.89	1.52	.53	2.24	.80	.52	1.31	11.81
West Virginia	3.86	1.65	2.31	.60	2.52	1.65	.84	1.68	15.11
Kentucky	4.25	1.49	1.72	.33	2.28	1.15	.61	1.41	13.24
Ohio	3.94	1.92	2.49	.46	2.08	2.14	.80	1.39	15.22
Michigan	2.22	3.00	2.45	.50	1.90	2.71	.86	1.46	15.10
Indiana	3.76	1.87	1.96	.38	1.82	1.43	.48	1.25	12.95
Illinois	3.82	1.85	1.50	.30	1.50	1.29	.40	1.10	11.76
Wisconsin	3.16	3.59	2.01	.44	1.68	2.32	.70	1.63	15.53
Minnesota	2.28	2.86	1.72	.37	1.66	1.78	.46	1.18	12.31
Iowa	2.71	1.28	1.44	.28	1.33	1.32	.34	1.22	9.92
Missouri	2.91	1.37	1.47	.34	1.69	1.06	.40	1.36	10.60
Kansas	2.24	1.16	1.24	.34	1.14	1.08	.38	1.02	8.60
Nebraska	2.19	1.62	1.38	.30	1.16	1.26	.40	1.10	9.41
South Dakota	1.52	1.42	1.50	.32	1.31	1.38	.33	1.11	8.89
North Dakota	1.20	1.64	1.78	.47	1.18	1.62	.47	1.25	9.61
Western	2.98	1.62	1.59	.34	1.53	1.35	.45	1.22	11.08
Colorado	2.40	2.45	1.94	.49	1.40	1.55	.79	1.56	12.58
Utah	5.47	4.42	2.85	.79	2.69	2.71	1.39	1.71	22.02
Idaho	3.82	2.50	3.23	1.38	2.98	2.72	1.54	3.20	21.37
Mountain region	2.61	2.58	2.01	.52	1.50	1.64	.84	1.59	13.29
Washington	3.24	3.40	2.10	.59	1.52	1.74	.92	2.08	15.59
Oregon	3.59	3.71	2.45	.68	2.30	1.59	.74	2.12	17.18
California	4.82	4.30	2.60	.69	1.98	2.08	.71	1.74	18.92
Pacific	4.50	4.14	2.53	.68	1.98	1.98	.73	1.82	18.36
Total	3.03	1.86	1.62	.42	1.80	1.22	.50	1.26	11.71

Estimated cost of the principal items and total cost in the production of wheat and corn by States per acre for 1893.

[Consolidated from returns from over 4,000 experts.]

States.	Wheat.										
	Rent of land per acre.	Manure.	Preparing ground (plowing, harrowing, etc).	Seed.	Sowing.	Harvesting.	Thrashing.	Housing.	Marketing.	Total.	Amount sown per acre
											Bush.
Maine	$2.90	$9.65	$3.77	$2.44	$1.32	$2.38	$2.63	$0.58	$1.13	$26.80	2
New Hampshire	4.40	5.00	3.42	2.40	.90	2.92	1.56	.50	1.08	22.18	2
Vermont	2.91	6.03	2.57	1.93	.56	2.36	1.39	.42	.83	19.00	1·9
Massachusetts	5.39	11.84	2.82	1.82	.53	1.90	2.42	.67	1.42	28.81	1·9
Rhode Island	......	......	......	......	......	......	......	......	......	......	......
Connecticut	5.36	8.50	3.66	1.74	.37	2.30	2.32	.58	1.25	26.08	1·9
New York	4.02	3.74	2.89	1.59	.47	1.52	1.29	.51	.84	16.91	1·8
New Jersey	4.41	5.20	2.20	1.44	.50	1.35	1.44	.69	.85	18.08	1·7
Pennsylvania	3.79	3.80	2.66	1.23	.46	1.34	1.26	.59	.75	15.88	1·5
Delaware	6.72	6.25	3.97	3.01	1.27	1.95	2.55	.72	.68	27.12	2·6
Maryland	3.19	3.44	2.26	1.03	.48	1.08	1.16	.51	.79	13.94	1·4
Virginia	2.25	2.43	1.85	.94	.47	.88	.83	.29	.81	10.75	1·2
North Carolina	2.61	2.31	1.48	.92	.38	.69	.73	.28	.60	9.47	1
South Carolina	1.87	2.30	1.18	.98	.27	.65	.61	.32	.60	8.37	1
Georgia	2.43	2.41	1.27	.94	.29	.69	.81	.22	.55	9.27	1
Florida	......	......	......	......	......	......	......	......	......	......	......
Alabama	2.29	2.45	1.48	.92	.39	.70	.78	.25	.54	9.05	1
Mississippi	2.35	3.09	1.48	1.05	.41	.87	1.01	.37	.75	10.30	1
Louisiana	2.50	2.10	1.42	1.20	.10	1.08	1.17	.38	.58	8.97	1·3
Texas	2.68	1.78	1.55	.74	.36	1.16	.93	.19	.63	8.13	1·1
Arkansas	2.61	2.25	1.51	.76	.32	.94	.71	.19	.82	7.79	1
Tennessee	2.66	1.73	1.49	.77	.34	.93	.93	.22	.55	8.94	1·1
West Virginia	2.93	2.08	2.28	1.06	.53	1.06	.98	.36	.77	11.39	1·4
Kentucky	3.14	1.89	1.57	.85	.34	1.08	1.22	.30	.63	10.08	1·8
Ohio	3.70	2.43	2.44	1.00	.45	1.26	1.40	.42	.74	13.38	1·5
Michigan	3.18	2.32	2.68	1.12	.33	1.35	1.17	.38	.79	13.32	1·7
Indiana	3.47	1.84	1.91	.85	.35	1.10	1.29	.31	.58	11.70	1·3
Illinois	3.50	1.75	1.45	.84	.25	1.03	1.10	.21	.49	10.62	1·3
Wisconsin	3.06	3.18	1.88	1.09	.42	1.08	1.06	.35	.82	12.94	1·7
Minnesota	2.19	2.94	1.65	.95	.35	1.20	1.02	.23	.48	11.01	1·5
Iowa	2.71	1.87	1.36	.99	.23	1.11	.98	.24	.52	9.09	1·6
Missouri	2.60	1.85	1.74	.68	.27	1.14	.97	.34	.58	8.94	1·3
Kansas	1.92	1.83	1.40	.63	.31	1.22	1.17	.25	.64	9.37	1·1
Nebraska	2.09	1.63	1.41	.78	.25	1.11	1.00	.22	.53	9.02	1·5
South Dakota	1.58	3.08	1.52	.79	.30	1.11	.91	.21	.49	7.52	1·5
North Dakota	1.49	1.15	1.64	.27	.39	1.05	1.19	.25	.57	7.48	1·3
Montana	4.04	3.50	2.46	1.28	.39	1.73	1.74	.68	1.77	17.59	1·7
Wyoming	2.17	......	2.00	1.05	.18	1.42	1.70	.16	1.67	10.35	1·5
Colorado	2.91	2.09	1.98	.88	.38	1.52	1.36	.43	.90	12.45	1·0
New Mexico	4.80	4.58	2.25	.99	.88	1.88	1.66	.44	1.53	19.01	1·3
Arizona	......	......	......	......	......	......	......	......	......	......	......
Utah	5.92	5.54	2.69	1.12	.37	1.91	1.92	.71	1.54	21.72	1·7
Nevada	......	......	......	......	......	......	......	......	......	......	......
Idaho	2.45	1.75	2.23	.90	.32	2.10	2.10	.57	1.77	14.19	1·4
Washington	4.03	3.06	2.22	.91	.33	1.55	1.72	.56	1.57	15.95	1·4
Oregon	2.83	1.76	2.06	.85	.33	1.39	1.33	.38	1.25	12.18	1·5
California	3.41	2.71	1.94	1.02	.20	1.39	1.12	.48	1.14	13.41	1·3
General average	2.75	2.34	1.85	.87	.35	1.17	1.13	.33	.69	11.48	1·4

Estimated cost of the principal items and total cost in the production of wheat and corn by States per acre for 1892—Continued.

States.	Corn.									
	Rent of land per acre.	Manure.	Preparing ground (plowing, harrowing, etc).	Seed.	Planting.	Cultivating.	Gathering.	Housing.	Marketing.	Total.
Maine	$3.47	$11.73	$3.90	$0.34	$1.66	$3.50	$4.87	$1.13	$2.72	$33.32
New Hampshire	4.45	9.09	4.27	.26	1.00	3.86	6.14	.80	2.93	32.80
Vermont	3.58	9.36	2.91	.34	1.28	3.22	5.41	75	1.83	28.68
Massachusetts	4.96	18.20	4.12	.36	1.50	3.73	6.92	1.37	2.42	43.58
Rhode Island	5.39	11.44	4.06	.28	1.86	3.47	5.04	1.25	2.17	34.96
Connecticut	4.95	12.70	4.36	.28	1.20	3.58	4.51	1.07	1.69	34.34
New York	4.51	5.16	3.11	.25	.80	2.52	4.34	.77	1.30	22.76
New Jersey	4.27	6.40	2.53	.16	.77	2.33	3.15	1.05	1.40	22.06
Pennsylvania	3.99	4.37	2.89	.18	.64	2.03	2.98	.74	1.35	19.17
Delaware	7.71	2.67	4.48	.57	1.97	3.25	4.35	1.16	1.35	27.51
Maryland	3.40	2.93	2.26	.14	.52	1.77	2.28	.66	1.41	15.37
Virginia	2.58	1.98	1.84	.15	.47	1.72	1.33	.48	1.23	11.78
North Carolina	2.94	2.33	1.38	.15	.42	2.18	.96	.25	.93	10.79
South Carolina	1.97	2.10	1.17	.14	.34	1.95	.74	.31	.66	8.98
Georgia	2.38	2.08	1.20	.14	.41	1.93	.71	.37	.76	9.37
Florida	2.04	3.66	1.56	.16	.66	.68	.98	.58	.84	11.42
Alabama	2.31	2.08	1.28	.15	.48	2.34	.73	.44	.81	9.83
Mississippi	2.77	3.11	1.51	.19	.48	2.55	.79	.61	1.13	11.22
Louisiana	3.28	2.67	1.69	.27	.57	2.30	1.02	.58	.93	11.39
Texas	2.48	1.83	1.41	.13	.44	1.79	.75	.39	.93	8.62
Arkansas	2.90	2.21	1.42	.13	.44	2.46	.96	.49	1.18	9.86
Tennessee	3.22	1.64	1.50	.13	.36	2.15	1.14	.42	1.23	10.85
West Virginia	3.29	2.09	2.32	.18	.55	2.58	2.08	.76	1.78	14.12
Kentucky	4.35	1.71	1.62	.17	.40	2.06	1.52	.66	1.32	12.34
Ohio	3.93	2.33	2.36	.15	.42	2.05	2.60	.60	1.21	14.96
Michigan	3.22	2.21	2.40	.18	.45	1.90	3.03	.63	1.38	15.40
Indiana	3.79	1.88	1.86	.13	.40	1.79	1.66	.44	1.15	13.10
Illinois	3.88	1.91	1.48	.12	.26	1.44	1.37	.31	.96	11.73
Wisconsin	3.17	1.99	3.25	.29	.43	1.69	3.00	.47	1.35	15.62
Minnesota	2.28	2.93	1.67	.26	.36	1.49	2.00	.32	.98	12.29
Iowa	2.76	1.78	1.41	.14	.29	1.31	1.34	.31	1.11	9.63
Missouri	2.70	1.75	1.55	.10	.32	1.74	1.20	.43	1.31	9.73
Kansas	2.00	1.98	1.33	.08	.32	1.11	1.15	.34	.99	9.30
Nebraska	2.02	1.60	1.36	.10	.29	1.12	1.13	.27	.93	8.82
South Dakota	1.61	2.46	1.50	.16	.32	1.50	1.48	.30	.87	8.43
North Dakota	2.01	1.61	1.69	.42	.62	1.17	1.64	.44	.92	8.06
Montana	6.13	......	2.88	.56	1.00	2.50	3.44	.76	1.25	18.52
Wyoming	......	......	......	......	......	......	......	......	......	......
Colorado	2.66	2.27	1.99	.19	.37	1.49	1.87	.47	1.05	12.36
New Mexico	3.86	7.88	2.19	.28	1.39	2.21	2.41	1.06	1.75	23.03
Arizona	......	......	......	......	......	......	......	......	......	......
Utah	5.43	4.58	2.33	.19	.61	2.42	3.92	.66	3.66	23.80
Nevada	......	......	......	......	......	......	......	......	......	......
Idaho	1.00	......	2.50	.50	1.00	6.50	8.00	......	......	19.50
Washington	2.50	4.00	1.95	.43	1.31	2.70	1.58	.50	2.01	16.99
Oregon	2.77	2.35	2.17	.33	.55	1.77	1.54	.88	.91	13.27
California	4.20	1.54	2.51	.34	.65	1.61	2.27	.74	2.66	16.52
General average	2.90	2.10	1.60	.14	.38	1.72	1.37	.42	1.08	11.71

REPORT ON FARM ANIMALS.

HORSES.

The returns of the number of horses show an increase of the same in 30 out of the 47 States and Territories, not including Oklahoma and the Indian reservations; a decrease in 17 of the States and Territories, and a general decrease as compared with the returns of January, 1893, of 125,663—the total number of horses in January last year being 16,206,802 against 16,081,139 same date in 1894. An increase is shown in all the New England and Middle States with the exception of New Jersey. In the Southern States decreases have occurred only in the States of Alabama, Louisiana, and Texas. The Western States present a numerical decrease in Ohio, Michigan, Illinois, Wisconsin, Kansas, South Dakota. There is also a decrease in the Mountain Division, including the States of Montana, Wyoming, Nevada, and Idaho, and the Territory of Utah. The States of California and Oregon also show decrease. Prices have declined in all the States and Territories excepting Rhode Island and Idaho. The average range is from $15.80 in New Mexico to $95.43 in Rhode Island, the average value being $47.83. In addition to the general depression, the low price of horses is attributed to the rapid substitution of electrical and other motors in the street-car service of towns and cities. There has been a slight general increase in the number of mules, the aggregate in January, 1894, being 2,352,231, against 2,331,128 in January, 1893, an increase of a little over 21,000. The average value of this animal has declined from $70.68 in January, 1893, to $62.17 the same date the present year.

MILCH COWS.

In spite of the financial depression, there is a tendency to an increase, though as yet slight, so far as indicated by the figures, in the number and value of milch cows. This is doubtless due to the firmness in price which dairy products have maintained in the market. The estimated present number is 16,487,400, against 16,424,087 in January, 1893; average price, $21.77, against $21.75, and aggregate value, $358,998,661, against $357,299,785 in January last year (1893).

OXEN AND OTHER CATTLE.

In the case of oxen and other cattle there is presented an increase in numbers over last year, but a slight decline in price and aggregate value. The number of these reported in January, 1893, was 35,954,196, at an average price of $15.24 and total value of $547,882,204. The returns of January, 1894, show the number to have increased to 36,608,168, but the average price has fallen, being $14.66 against $15.24, while the total value is $536,789,747, against $547,882,204. The reduction in the value of this class of stock is $1,092,457 and the fall in average price 58 cents per head, as compared with January, 1893.

SHEEP.

Sheep have suffered a rather abrupt decline in number, price, and, of course, aggregate value since January, 1893. The ravages of dogs are generally referred to by correspondents as one of the checks upon

the progress of this valuable industry. Although swine have, like sheep, fallen off in numbers to a considerable extent, the decline in price is not so marked, and a reaction toward higher prices is everywhere discernible.

COMPARISONS AND VALUES OF FARM ANIMALS.

In addition to the general financial depression, the scarcity of feed is assigned as an important factor in producing the decline both in numbers and values of farm animals. The numbers and values are compared in the following tables:

Numbers of farm animals in 1893 and 1894.

Stock.	1893.	1894.	Increase or decrease.	Per cent of increase or decrease.
Horses	16, 206, 802	16, 081, 139	—125, 663	—·78
Mules	2, 331, 128	2, 352, 231	+21, 103	+·91
Milch cows	16, 424, 087	16, 487, 400	+63, 313	+·39
Oxen and other cattle	35, 954, 196	36, 608, 168	+653, 972	+1·82
Sheep	47, 273, 553	45, 048, 017	—2, 225, 536	—4·71
Swine	46, 094, 807	45, 206, 498	—888, 309	—1·93
Total	164, 284, 573	161, 783, 453	—2, 501, 120	—1·53

The average value per head for all ages for all classes of animals, as compared with values of 1893, with increase or decrease, is here given:

Value per head of farm animals in 1893 and 1894.

Stock.	1893.	1894.	Increase or decrease.	Per cent of increase or decrease.
Horses	$61. 22	$47. 83	—$13. 39	—21·9
Mules	70. 68	62. 17	—8. 51	—12
Milch cows	21. 73	21. 77	+. 04	....
Oxen and other cattle	15. 24	14. 66	—. 58	—3·8
Sheep	2. 66	1. 98	—. 68	—25·6
Swine	6. 41	5. 98	—. 43	—6·7

The aggregate value is shown by the following table to be less by $312,266,495 than that of 1893. Decrease in the number of horses coincides, as will be seen, with a large diminution of value. Mules have increased in numbers less than 1 per cent, but decreased in price per head 12 per cent and in aggregate value over 11 per cent. Milch cows have increased in aggregate value and number but slightly. Oxen and other cattle show increase in number but decrease in value, while sheep and hogs have declined in both respects. The following statement gives a comparison of aggregate values of two enumerations:

Comparison of aggregate values of farm animals in 1893 and 1894.

Stock.	1893.	1894.	Increase or decrease.	Per cent of increase or decrease.
Horses	$992, 225, 185	$769, 224, 799	—$223, 000, 386	—22·5
Mules	164, 763, 751	146, 232, 811	—18, 530, 940	—11·2
Milch cows	356, 876, 353	358, 998, 661	+2. 122, 308	+·59
Oxen and other cattle	547, 882, 204	536, 789, 747	—11, 092, 457	—2
Sheep	125, 909, 264	89, 186, 110	—36, 723, 154	+29·2
Swine	295, 426, 492	270, 384, 626	—25, 041, 866	—8·5
Total	2, 483, 083, 249	2, 170, 816, 754	—312, 266, 495	—12·6

The following table shows the Chicago market prices in the first week in January, 1893 and 1894:

Chicago market prices of cattle, sheep, and hogs, per 100 pounds.

Species and grades.	1893.		1894.	
Cattle:				
Choice shipping	\$5.30	to \$6.00	\$5.34	to \$5.94
Fair to good	3.90	4.60	3.42	4.02
Sheep:				
Native	3.20	5.40	1.25	3.75
Western	3.00	5.25	1.75	3.50
Hogs:				
Rough packing	7.00	7.20	4.97	5.13
Heavy packing	7.25	7.55	5.18	5.43

The following table shows the changes in the price of swine in Chicago on the days named in the years 1893 and 1894:

Prices of swine at Chicago in 1893 and 1894.

Swine.	Jan. 6, 1894.		Jan. 6, 1893.		Feb. 6, 1894.	
Pigs	\$4.10	to \$5.20	\$5.90	to \$7.10	\$4.30	to \$5.20
Light	5.05	5.35	6.95	7.35	5.00	5.25
Rough packing	4.90	5.05	7.00	7.20	4.90	5.05
Mixed	5.05	5.35	7.05	7.45	5.05	5.30
Heavy	5.10	5.35	7.25	7.55	5.10	5.35

ESTIMATED RATE OF INCREASE OR DECREASE IN THE NUMBER OF FARM ANIMALS IN THE UNITED STATES WITH REFERENCE TO EACH OTHER AND TO POPULATION.

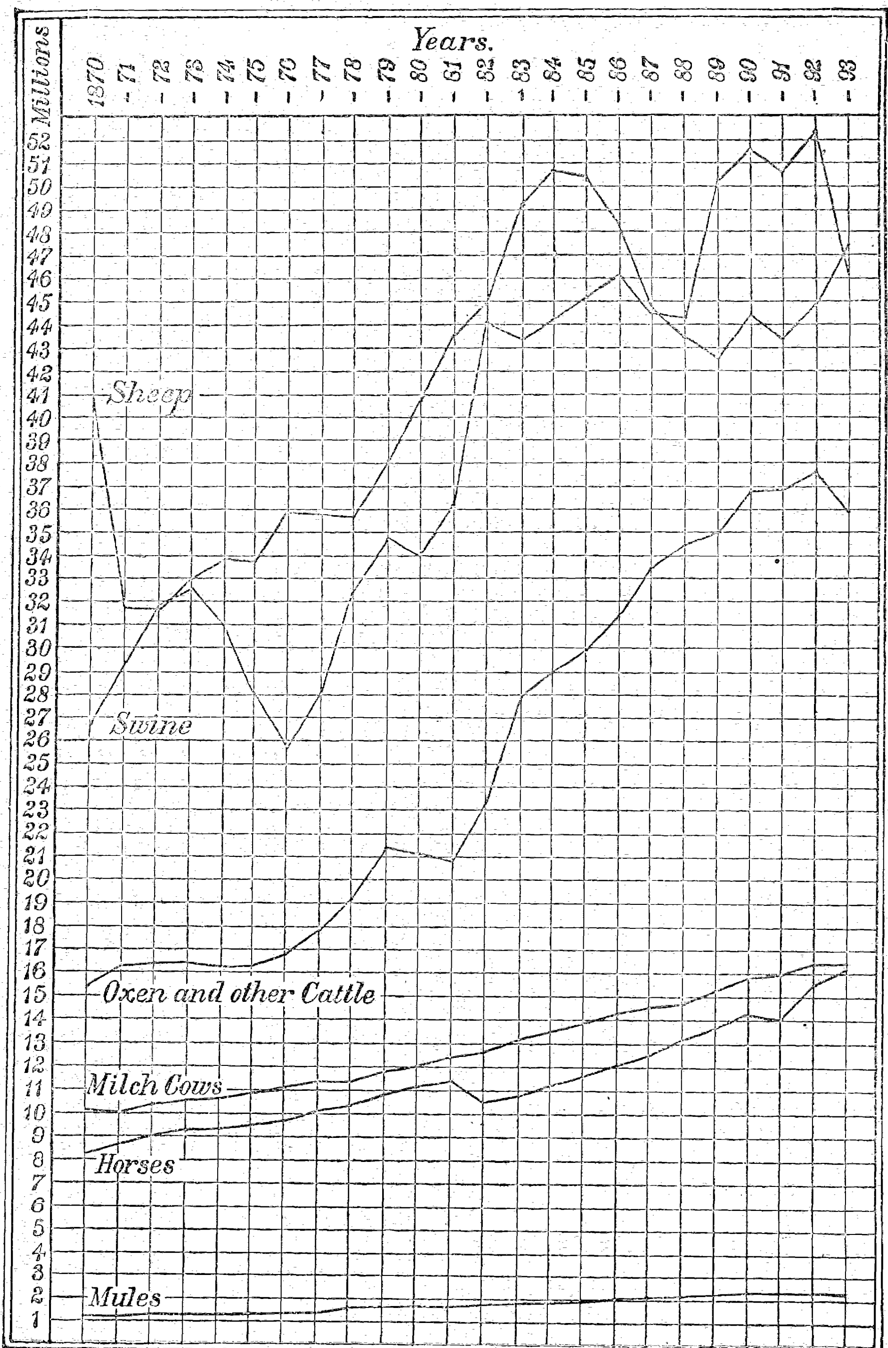
The following is an attempt to estimate the average annual rate of increase or decrease in the number of farm animals in the two decades 1870–1880 and 1880–1890, and for the triennium 1890–1893, relatively to the increase of population during the same periods and to each other. The years 1870, 1880, and 1890 were chosen because the figures of population are available for these years. The calculations are based on the numbers of farm animals as estimated by the Department of Agriculture.

The rate of increase in the number of horses was more or less uniform in the two decades 1870–1880 and 1880–1890, the average annual rate for the former period being 3·11 per cent and for the latter 2·41 per cent. In the triennium 1890–1893 there were larger fluctuations, a small decrease in the first year and a proportionately large increase during the following two years, the average annual rate of increase for the period being 4·59 per cent.

The number of mules increased with more or less regularity during the two decades 1870–1880 and 1880–1890, the average annual rate being 3·9 per cent for the former and 3·03 per cent for the latter. In the triennium 1890–1893 there was a decrease in the first year and an increase in the following two years, making the number at the end of these three years nearly equal to that at the beginning

The following diagram shows the comparative number of farm animals and the relative increase or decrease for each year of the period 1870 to 1893, inclusive:

FIG. 1—*Diagram showing the numbers of farm animals in the United States for the years 1870–1893, inclusive.*



The number of milch cows increased in the three periods under consideration at varying rates, the average annual rate for the first decade being 1·77 per cent; for the second decade, 2·87 per cent and for the last three years, 0·98.

The increase in the number of oxen and other cattle since 1870 has been very irregular. In the first six years the number remained nearly stationary; the next three years showed a large proportional increase, and the two years 1879–1881 a small decrease. A very great increase occurred from 1881 to 1883, and the remainder of the second decade showed a smaller gradual increase. In the triennium 1890–1893 the number of cattle increased somewhat during the first two years, and in the third year fell below the number at the beginning of the period.

The number of sheep and swine presents many fluctuations, which are not exhibited by a statement of the average annual rate of increase for the three periods under consideration.

In the total number of these farm animals the average annual rate of increase during the decade 1870–1880 was 1·67 per cent. In the following decade it rose to 3·17 per cent, and in the triennium 1890–1893 there was an average annual decrease of two-tenths of 1 per cent.

The following statement presents in detail the results of this investigation:

Average annual rate of increase or decrease in the numbers of farm animals in the United States.

Period.	Population.	Horses.	Mules.	Milch cows.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1870–'80	2·66	3·11	3·9	3·28
1880–'90	2·24	2·41	3·03	2·87
1890–'93	....	4·59	....	·98

Period.	Population.	Oxen and other cattle.	Sheep.	Swine.	Total farm animals.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1870–'80	2·66	3·28	—·02	2·44	1·67
1880–'90	2·24	5·66	·84	4·25	3·17
1890–'93	....	—·82	2·16	—3·83	—·20

For the purpose of comparison the numbers and values of the various animals on farms in the United States are given for the series of years 1868 to 1894, inclusive.

Numbers and values of farm animals in the United States for the years 1868–1894.

January 1—	Horses.		Mules.		Milch cows.	
	Number.	Value.	Number.	Value.	Number.	Value.
1868	5,756,940	$432,696,226	855,685	$66,415,769	8,691,568	$319,681,153
1869	6,332,793	533,024,787	921,662	98,386,359	9,247,714	361,752,676
1870	8,248,800	671,319,461	1,179,500	128,584,796	10,095,600	394,940,745
1871	8,702,000	683,257,587	1,242,300	126,127,786	10,023,000	374,179,093
1872	8,990,900	659,707,916	1,276,300	121,027,316	10,303,500	329,408,983
1873	9,222,470	684,463,957	1,310,000	124,658,085	10,575,900	314,358,931
1874	9,333,800	666,927,406	1,339,350	119,501,859	10,705,300	299,609,309
1875	9,504,200	646,370,939	1,393,750	111,502,713	10,906,800	311,089,824
1876	9,735,300	632,446,985	1,414,500	106,565,114	11,085,400	320,346,728
1877	10,155,400	610,206,631	1,443,500	99,480,976	11,260,800	307,743,211
1878	10,329,700	600,813,681	1,637,500	104,322,939	11,300,100	298,499,866
1879	10,938,700	573,254,808	1,713,100	96,033,971	11,826,400	256,953,928
1880	11,201,800	613,296,611	1,729,500	105,948,319	12,027,000	279,899,420
1881	11,429,626	667,954,325	1,720,731	120,096,164	12,368,653	296,277,060
1882	10,521,554	615,824,914	1,835,166	130,945,378	12,611,632	326,480,310
1883	10,838,111	765,041,308	1,871,079	148,732,390	13,125,685	396,575,405
1884	11,169,683	833,734,400	1,914,126	161,214,976	13,501,206	423,486,649
1885	11,564,572	852,282,947	1,972,569	162,497,097	13,904,722	412,903,093
1886	12,077,657	860,823,208	2,052,593	163,381,096	14,235,388	389,985,523
1887	12,496,744	901,685,755	2,117,141	167,057,538	14,522,083	378,789,589
1888	13,172,936	946,096,154	2,191,727	174,853,563	14,856,414	366,252,173
1889	13,663,294	982,194,827	2,257,574	179,444,481	15,298,625	366,226,376
1890	14,213,837	978,516,562	2,331,027	182,394,099	15,952,883	352,152,133
1891	14,056,750	941,823,222	2,296,532	178,847,370	16,019,591	346,397,900
1892	15,498,140	1,007,593,636	2,314,699	174,882,070	16,416,351	351,378,132
1893	16,206,802	992,225,185	2,331,128	164,763,751	16,424,087	357,299,785
1894	16,081,139	769,224,799	2,352,231	146,232,811	16,487,400	358,998,661

Jan. 1—	Oxen and other cattle.		Sheep.		Swine.		Total value farm animals.
	Number.	Value.	Number.	Value.	Number.	Value.	
1868	11,942,484	$249,144,599	38,991,912	$98,407,809	24,317,258	$110,766,266	$1,277,111,822
1869	12,185,385	306,211,473	37,724,279	82,139,979	23,316,476	146,188,755	1,527,704,029
1870	15,388,500	346,926,440	40,853,000	93,364,433	26,751,400	187,191,502	1,822,327,377
1871	16,212,200	369,940,056	31,851,000	74,035,837	29,457,500	182,602,352	1,810,142,711
1872	16,389,800	321,562,693	31,679,300	88,771,197	31,796,300	138,733,828	1,659,211,933
1873	16,413,800	329,298,755	33,002,400	97,922,350	32,632,050	133,729,615	1,684,431,693
1874	16,218,100	310,649,803	33,928,200	88,690,569	30,860,900	134,565,526	1,619,944,472
1875	16,313,400	304,858,859	33,783,600	94,320,652	28,062,200	149,869,234	1,618,012,221
1876	16,785,300	319,623,509	35,935,300	93,666,318	25,726,800	175,070,484	1,647,719,138
1877	17,956,100	307,105,386	35,804,200	80,892,683	28,077,100	171,077,196	1,576,506,083
1878	19,223,300	329,541,703	35,740,500	80,603,062	32,262,500	160,838,532	1,574,620,783
1879	21,408,100	329,543,327	38,123,800	79,023,984	34,766,100	110,613,044	1,445,423,062
1880	21,231,000	341,761,154	40,765,900	90,230,537	34,034,100	145,781,515	1,576,917,556
1881	20,937,702	362,861,509	43,576,899	104,070,759	36,247,603	170,535,435	1,721,795,252
1882	23,280,238	463,069,499	45,016,224	106,594,954	44,122,200	263,543,195	1,906,459,250
1883	28,046,077	611,549,109	49,237,291	124,365,835	43,270,086	291,951,221	2,338,215,268
1884	29,046,101	683,229,054	50,626,626	119,902,706	44,200,893	246,301,139	2,467,868,924
1885	29,866,573	694,382,913	50,360,243	107,960,650	45,142,657	226,401,683	2,456,428,383
1886	31,275,242	661,956,274	48,322,331	92,443,867	46,092,043	196,569,894	2,365,159,862
1887	33,511,750	663,137,926	44,759,314	89,872,839	44,612,836	200,043,291	2,400,586,938
1888	34,378,363	611,750,520	43,544,755	89,279,926	44,346,525	220,811,082	2,409,043,418
1889	35,032,417	597,236,812	42,599,079	90,640,369	50,301,592	291,307,193	2,507,050,058
1890	36,849,024	560,625,137	44,336,072	100,659,761	51,602,780	243,418,336	2,413,766,028
1891	36,875,648	544,127,908	43,431,136	108,397,447	50,625,106	210,193,928	2,329,787,770
1892	37,651,239	570,749,155	44,938,365	116,121,290	52,398,019	241,031,415	2,461,755,698
1893	35,954,196	547,882,204	47,273,553	125,909,264	46,094,807	295,426,492	2,483,506,681
1894	36,608,168	536,789,747	45,048,017	89,186,110	45,206,498	270,384,626	2,170,816,754

Estimated prices of animals on farms and ranches in January, 1894.

States and Territories.	Horses.				Mules.				Milch cows.
	Under 1 year old.	Between 1 and 2 years old.	Between 2 and 3 years old.	Over 3 years old.	Under 1 year old.	Between 1 and 2 years old.	Between 2 and 3 years old.	Over 3 years old.	
Maine	$23.93	$35.13	$54.67	$75.78	....	....	....	....	$21.37
New Hampshire	21.63	35.38	50.13	67.50	....	....	....	....	21.81
Vermont	20.90	32.85	46.30	70.30	....	....	....	....	25.25
Massachusetts	29.20	44.00	66.17	78.00	....	....	....	....	32.50
Rhode Island	39.20	60.00	80.00	102.25	....	....	....	....	26.60
Connecticut	29.06	45.56	72.25	101.37	....	....	....	....	28.94
New York	27.15	41.94	62.43	85.93	$27.73	$42.55	$63.91	$86.79	25.78
New Jersey	35.71	55.36	75.21	97.50	40.00	55.00	92.50	105.42	35.20
Pennsylvania	24.85	40.17	60.27	80.76	31.40	43.92	74.28	92.69	25.55
Delaware	18.50	22.50	45.75	60.00	20.50	44.50	80.00	90.00	24.50
Maryland	24.53	39.67	60.00	80.33	30.67	49.92	75.62	102.69	23.63
Virginia	23.52	35.26	52.30	70.12	27.53	41.57	64.05	83.17	18.08
North Carolina	30.01	45.94	66.32	84.40	32.88	48.95	73.40	92.16	14.99
South Carolina	28.06	47.78	67.78	90.21	32.06	52.94	78.53	106.84	20.47
Georgia	30.10	45.27	64.16	86.06	34.03	52.21	76.83	99.71	16.44
Florida	24.56	39.17	54.74	78.75	26.67	43.75	68.33	97.81	13.68
Alabama	22.74	35.17	50.14	67.92	26.03	40.63	60.09	76.56	12.45
Mississippi	20.38	29.47	42.45	61.59	25.83	37.59	54.14	75.21	12.91
Louisiana	15.17	23.51	33.88	57.76	21.19	33.09	56.09	89.55	16.50
Texas	11.91	17.39	24.50	35.73	20.71	29.52	41.34	56.23	13.84
Arkansas	20.82	28.61	40.29	55.66	27.50	38.50	53.96	73.00	10.76
Tennessee	29.05	42.20	56.76	70.87	32.60	47.25	64.59	79.82	16.45
West Virginia	21.69	32.49	45.43	63.17	25.13	37.31	52.95	72.52	19.15
Kentucky	27.15	40.08	58.61	71.66	30.57	44.62	63.37	76.54	20.39
Ohio	23.85	35.87	55.32	70.67	25.59	37.70	52.19	71.36	25.94
Michigan	25.83	42.14	55.06	75.40	28.00	44.00	62.00	85.00	28.27
Indiana	24.65	34.92	47.84	64.33	27.17	39.44	55.10	71.24	24.16
Illinois	20.29	29.65	41.94	57.00	24.74	34.63	48.34	65.64	25.12
Wisconsin	23.72	36.07	50.86	72.87	23.83	36.83	51.97	72.76	24.34
Minnesota	22.21	36.60	52.31	73.74	25.22	41.04	57.04	79.57	19.42
Iowa	18.22	26.97	39.45	57.30	21.73	31.73	46.34	65.89	23.57
Missouri	18.84	27.07	37.20	50.23	24.23	34.34	48.08	64.20	17.67
Kansas	16.79	24.93	34.95	49.87	21.57	31.82	44.71	63.84	18.15
Nebraska	16.30	24.36	36.26	51.07	21.31	32.56	47.84	66.82	19.61
South Dakota	18.90	28.92	43.47	59.72	21.35	32.48	48.05	67.58	19.12
North Dakota	21.00	33.61	53.34	77.32	21.67	36.67	56.67	80.47	19.79
Montana	9.88	15.43	24.89	32.21	17.40	24.30	36.00	66.43	24.67
Wyoming	9.40	14.40	25.00	33.00	15.00	22.50	35.00	65.00	24.60
Colorado	11.60	18.10	27.63	37.20	16.90	27.85	44.69	65.33	23.06
New Mexico	5.70	10.00	14.92	20.33	8.60	15.08	26.33	37.17	20.00
Arizona	12.50	17.50	25.00	35.00	....	....	....	....	17.50
Utah	9.00	15.22	23.44	34.78	7.75	12.00	31.67	43.00	18.00
Nevada	8.50	13.00	20.63	32.50	15.00	21.25	33.75	55.00	29.30
Idaho	12.30	16.00	24.83	34.82	15.67	20.67	26.67	41.67	21.67
Washington	22.09	30.50	35.47	51.53	24.40	36.00	49.40	77.88	28.72
Oregon	12.91	18.41	27.02	42.29	20.85	31.50	42.75	60.00	21.35
California	15.56	23.17	35.99	54.50	22.00	33.36	50.81	71.81	25.82
Oklahoma	....	....	....	....	....	....	....	....	18.00
Total	20.19	30.20	43.63	61.42	26.79	39.11	56.61	77.57	21.77

Estimated prices of animals on farms and ranches in January, 1894—Continued.

States and Territories.	Oxen and other cattle.				Sheep.		Swine.	
	Under 1 year old.	Between 1 and 2 years old.	Between 2 and 3 years old.	Over 3 years old.	Under 1 year old.	Over 1 year old.	Under 1 year old.	Over 1 year old.
Maine	$8.00	$12.94	$22.06	$35.75	$1.77	$2.15	$6.96	$15.63
New Hampshire	7.59	13.25	18.25	32.31	2.03	2.53	8.49	16.20
Vermont	6.88	12.00	19.00	27.00	2.00	2.22	7.80	12.85
Massachusetts	9.20	14.10	22.60	40.20	3.50	3.70	9.50	17.17
Rhode Island	7.00	12.60	19.80	25.00	3.20	3.80	9.50	18.40
Connecticut	10.38	16.25	24.06	35.63	3.21	3.53	9.00	17.88
New York	8.65	14.60	21.64	34.72	2.48	2.98	7.08	13.77
New Jersey	12.92	19.58	26.75	37.58	3.90	4.15	8.00	15.00
Pennsylvania	8.59	16.86	21.95	29.93	2.66	3.27	6.93	13.32
Delaware	8.00	12.00	18.00	20.00	3.00	3.25	3.50	5.00
Maryland	8.63	13.87	21.03	31.43	2.81	3.20	5.40	10.27
Virginia	6.01	9.77	15.36	21.79	2.18	2.70	3.29	7.03
North Carolina	4.05	7.11	11.48	15.75	1.15	1.63	2.83	5.97
South Carolina	5.21	8.15	11.68	16.89	1.27	1.71	3.84	8.25
Georgia	4.31	6.62	9.86	13.50	1.22	1.71	2.98	6.26
Florida	4.19	6.00	8.34	11.80	1.23	1.97	1.63	3.72
Alabama	2.96	4.63	6.73	9.92	.99	1.33	2.43	4.90
Mississippi	3.02	4.89	7.40	11.06	1.10	1.55	2.43	5.50
Louisiana	4.06	5.81	9.63	12.54	1.00	1.75	2.33	5.87
Texas	4.52	7.60	9.70	13.16	1.02	1.47	2.87	6.43
Arkansas	2.83	4.48	6.73	10.34	1.03	1.50	2.13	4.82
Tennessee	4.40	7.76	12.33	16.72	1.16	1.98	3.72	7.58
West Virginia	6.88	12.35	19.20	26.74	1.66	2.35	3.74	8.01
Kentucky	6.48	10.96	17.47	25.17	1.93	2.65	3.61	8.06
Ohio	8.34	14.40	23.03	31.83	1.62	2.52	5.15	10.36
Michigan	7.57	13.37	21.60	31.03	1.81	2.51	5.77	11.12
Indiana	7.83	14.17	21.86	30.27	2.03	2.57	5.11	10.53
Illinois	7.66	13.17	20.37	28.22	1.89	2.61	5.57	10.71
Wisconsin	6.41	11.08	17.34	26.43	1.78	2.34	6.27	11.59
Minnesota	5.11	8.86	14.56	21.80	1.64	2.45	5.73	11.23
Iowa	8.04	14.00	21.97	29.74	2.11	2.81	6.73	12.12
Missouri	6.98	11.17	17.08	23.42	1.47	2.13	3.74	7.48
Kansas	6.77	11.84	18.35	25.06	1.43	2.23	5.45	10.56
Nebraska	6.99	11.90	18.77	24.58	1.63	2.65	6.44	11.80
South Dakota	6.05	10.88	16.88	24.21	1.70	2.47	5.72	11.65
North Dakota	6.46	11.28	17.93	25.19	1.27	2.33	4.40	11.70
Montana	8.00	11.93	17.20	24.33	1.27	2.00	7.09	14.18
Wyoming	6.60	11.20	16.60	21.90	1.50	2.45	5.00	11.40
Colorado	7.96	10.77	16.28	20.95	1.23	2.05	6.23	10.89
New Mexico	4.33	6.83	11.20	14.20	.68	1.55	5.67	10.08
Arizona	4.00	7.00	11.00	15.00	1.13	1.63	4.50	9.50
Utah	5.22	8.61	13.50	17.94	1.21	1.84	6.93	11.88
Nevada	6.81	9.05	14.60	19.20	1.38	2.45	5.97	12.91
Idaho	6.17	10.17	15.08	19.17	1.33	1.83	4.67	9.67
Washington	8.53	13.27	19.93	33.53	1.87	2.66	4.05	8.10
Oregon	6.06	10.07	15.24	21.53	1.25	2.00	3.38	6.72
California	7.44	11.87	17.49	23.23	1.28	2.00	4.11	8.17
Total	6.16	10.56	16.05	21.55	1.49	2.20	4.70	8.85

Estimated numbers of animals on farms and ranches, total value of each kind, and average price, January, 1894.

States and Territories.	Horses.			Mules.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	116, 604	$63. 07	$7, 354, 453			
New Hampshire	56, 741	57. 58	3, 267, 145			
Vermont	94, 825	54. 54	5, 171, 851			
Massachusetts	65, 760	73. 03	4, 802, 581			
Rhode Island	10, 443	95. 43	996, 565			
Connecticut	45, 766	89. 95	4, 116, 471			
New York	702, 821	71. 81	50, 466, 294	4, 819	$78. 09	$376, 334
New Jersey	83, 321	85. 27	7, 105, 037	8, 296	101. 69	843, 644
Pennsylvania	659, 484	63. 77	42, 053, 101	36, 513	81. 86	2, 989, 014
Delaware	29, 386	50. 53	1, 484, 924	5, 559	86. 55	480, 343
Maryland	136, 359	63. 37	8, 641, 027	13, 213	91. 43	1, 208, 013
Virginia	251, 145	56. 04	14, 074, 839	39, 422	69. 92	2, 756, 406
North Carolina	134, 517	72. 20	9, 712, 005	109, 762	77. 64	8, 521, 935
South Carolina	62, 635	81. 92	5, 130, 853	95, 994	95. 93	9, 208, 744
Georgia	105, 984	73. 47	7, 786, 699	161, 204	88. 34	14, 240, 462
Florida	33, 144	66. 40	2, 200, 674	8, 365	86. 64	724, 721
Alabama	119, 806	57. 31	6, 866, 130	125, 936	67. 14	8, 455, 692
Mississippi	164, 250	52. 69	8, 654, 912	150, 860	67. 01	10, 109, 598
Louisiana	130, 804	46. 24	6, 047, 731	92, 805	78. 83	7, 316, 191
Texas	1, 183, 895	27. 20	32, 203, 376	253, 839	44. 72	11, 351, 535
Arkansas	196, 545	45. 58	8, 958, 806	139, 882	60. 46	8, 457, 762
Tennessee	334, 408	56. 34	18, 839, 662	198, 171	58. 92	11, 675, 375
West Virginia	163, 312	46. 46	7, 586, 792	7, 601	55. 39	421, 036
Kentucky	430, 941	56. 24	24, 237, 842	150, 225	54. 94	8, 253, 398
Ohio	864, 360	54. 85	47, 408, 255	20, 700	58. 95	1, 220, 326
Michigan	503, 779	60. 22	30, 335, 949	3, 026	78. 50	237, 536
Indiana	761, 954	50. 31	38, 331, 935	57, 688	56. 20	3, 241, 815
Illinois	1, 308, 771	43. 40	56, 799, 353	104, 720	51. 26	5, 367, 573
Wisconsin	475, 674	57. 17	27, 193, 118	5, 025	63. 40	318, 579
Minnesota	498, 772	59. 43	29, 640, 542	9, 269	70. 81	656, 370
Iowa	1, 367, 329	43. 73	59, 792, 200	36, 187	53. 56	1, 938, 145
Missouri	1, 008, 361	38. 25	38, 569, 008	256, 828	45. 91	11, 791, 483
Kansas	950, 564	40. 42	38, 421, 979	97, 019	53. 41	5, 182, 029
Nebraska	708, 457	41. 08	29, 106, 808	46, 939	56. 94	2, 672, 932
South Dakota	290, 862	45. 82	13, 328, 256	7, 380	60. 67	447, 712
North Dakota	163, 499	57. 72	9, 436, 840	7, 840	71. 85	563, 274
Montana	196, 519	26. 00	5, 108, 703	994	45. 49	45, 217
Wyoming	82, 524	24. 09	1, 988, 009	1, 505	57. 06	85, 870
Colorado	194, 731	30. 27	5, 894, 768	9, 163	61. 07	559, 563
New Mexico	92, 963	15. 80	1, 468, 507	3, 747	31. 37	117, 530
Arizona	52, 697	21. 75	1, 146, 160	1, 327	30. 75	40, 805
Utah	69, 112	21. 94	1, 516, 265	1, 789	31. 37	56, 123
Nevada	55, 793	23. 60	1, 316, 764	1, 604	39. 25	62, 965
Idaho	144, 688	48. 00	6, 945, 024	990	45. 75	45, 293
Washington	198, 076	40. 59	8, 040, 067	1, 392	69. 18	96, 295
Oregon	235, 607	29. 49	6, 947, 718	6, 182	44. 98	278, 064
California	513, 636	41. 98	21, 562, 949	63, 033	56. 38	3, 553, 899
Oklahoma	29, 515	39. 50	1, 165, 843	5, 427	48. 50	263, 210
Total	16, 081, 139	47. 83	769, 224, 799	2, 352, 231	62. 17	146, 232, 811

Estimated numbers of animals on farms and ranches, total value of each kind, and average price, January, 1894—Continued.

States and Territories.	Milch cows.			Oxen and other cattle.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	177,602	$21.37	$3,795,355	130,528	$24.37	$3,181,617
New Hampshire	112,585	21.81	2,455,479	92,898	22.69	2,107,888
Vermont	246,022	25.25	6,212,056	152,681	19.67	3,003,164
Massachusetts	178,135	32.50	5,789,388	86,422	26.71	2,308,502
Rhode Island	24,765	26.60	658,749	11,713	21.13	247,451
Connecticut	137,582	28.94	3,981,623	76,886	27.65	2,125,980
New York	1,572,443	25.78	40,537,581	706,597	26.16	18,484,989
New Jersey	190,734	35.20	6,713,837	52,641	29.11	1,532,272
Pennsylvania	938,382	25.55	23,975,660	737,919	21.64	15,965,972
Delaware	33,836	24.50	828,982	26,544	17.44	462,924
Maryland	147,526	23.63	23,486,039	112,644	21.79	2,454,883
Virginia	276,617	18.08	5,001,235	411,006	15.10	6,206,936
North Carolina	274,794	14.99	4,119,162	386,463	11.15	4,308,446
South Carolina	125,619	20.47	2,571,421	161,668	12.10	1,955,390
Georgia	312,742	16.44	5,141,478	557,645	9.59	5,350,268
Florida	114,332	13.68	1,564,062	375,981	8.28	3,111,393
Alabama	311,743	12.45	3,881,200	545,134	6.85	3,735,805
Mississippi	302,959	12.91	3,911,201	555,588	7.68	4,268,363
Louisiana	175,784	16.50	2,900,436	391,131	9.06	3,544,504
Texas	808,515	13.84	11,189,848	6,591,787	9.50	62,604,840
Arkansas	328,697	10.76	3,536,780	654,376	7.02	4,593,263
Tennessee	351,499	16.45	5,782,159	575,206	10.44	6,006,704
West Virginia	182,265	19.15	3,490,375	354,376	15.20	5,387,721
Kentucky	329,552	20.39	6,719,565	599,004	15.72	9,417,597
Ohio	767,735	25.94	19,915,046	803,236	20.89	16,780,881
Michigan	468,711	28.27	13,250,460	472,397	20.10	9,494,054
Indiana	656,982	24.16	15,872,685	904,001	20.11	18,178,747
Illinois	1,039,121	25.12	26,102,720	1,553,383	18.66	28,984,266
Wisconsin	787,390	24.34	19,165,073	779,224	17.52	13,651,693
Minnesota	577,196	19.42	11,209,146	778,038	13.74	10,687,365
Iowa	1,278,231	23.57	30,127,905	2,731,385	19.79	54,064,497
Missouri	784,841	17.67	13,868,140	1,850,175	15.20	28,120,259
Kansas	668,914	18.15	12,140,789	1,978,322	16.54	32,713,134
Nebraska	535,536	19.61	10,501,861	1,613,223	16.70	26,941,631
South Dakota	290,550	19.12	5,555,316	467,400	16.10	7,523,317
North Dakota	140,700	19.79	2,784,453	250,566	16.84	4,219,914
Montana	36,419	24.67	898,457	1,056,952	15.73	16,627,979
Wyoming	17,815	24.60	438,249	852,437	13.99	11,923,042
Colorado	76,124	23.06	1,755,419	996,301	15.53	15,468,276
New Mexico	18,400	20.00	368,000	1,224,546	9.44	11,556,533
Arizona	14,878	17.50	260,365	649,502	11.25	7,306,898
Utah	56,143	18.00	1,010,574	351,584	11.59	4,075,882
Nevada	18,196	29.30	533,143	259,078	12.97	3,360,732
Idaho	30,419	21.67	659,180	429,947	12.50	5,374,338
Washington	108,535	28.72	3,117,125	408,293	20.79	8,487,108
Oregon	110,398	21.35	2,356,997	804,543	14.97	12,041,277
California	329,161	25.82	8,498,937	925,578	16.17	14,962,157
Oklahoma	20,275	18.00	364,950	121,219	15.50	1,878,895
Total	16,487,400	21.77	358,998,661	36,608,168	14.66	536,789,747

Estimated numbers of animals on farms and ranches, total value of each kind, and average price, January, 1894—Continued.

States and Territories.	Sheep.			Hogs.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	326,937	$2.05	$671,855	79,995	$8.69	$695,476
New Hampshire	115,471	2.38	274,821	51,658	10.42	538,151
Vermont	280,170	2.16	604,719	76,268	9.11	695,032
Massachusetts	51,441	3.65	187,760	63,895	11.34	724,622
Rhode Island	11,279	3.65	41,168	13,481	11.28	152,064
Connecticut	39,930	3.46	138,014	53,786	10.78	579,596
New York	1,388,051	2.85	3,962,885	658,605	9.02	5,940,680
New Jersey	57,571	4.08	235,177	182,830	10.84	1,981,880
Pennsylvania	1,473,494	3.07	4,530,700	1,033,517	8.78	9,077,483
Delaware	12,873	3.18	40,968	52,167	3.80	198,234
Maryland	145,446	3.08	447,843	328,732	7.10	2,335,475
Virginia	488,432	2.55	1,247,651	920,228	4.41	4,060,044
North Carolina	376,309	1.49	559,195	1,334,966	3.99	5,328,916
South Carolina	78,384	1.58	123,690	767,521	5.43	4,165,799
Georgia	411,169	1.57	646,687	1,791,567	4.16	7,454,352
Florida	112,885	1.79	202,335	388,074	2.38	924,548
Alabama	343,832	1.22	421,057	1,514,249	3.29	4,988,693
Mississippi	415,855	1.42	588,435	1,577,208	3.47	5,478,907
Louisiana	184,273	1.52	279,634	806,168	3.75	3,019,904
Texas	3,814,405	1.33	5,075,065	2,555,459	4.29	10,973,142
Arkansas	228,310	1.34	307,654	1,547,689	3.21	4,961,892
Tennessee	519,770	1.81	939,952	1,930,049	4.80	9,265,780
West Virginia	765,705	2.12	1,619,772	407,344	4.85	1,975,698
Kentucky	1,163,098	2.41	2,797,483	1,794,849	4.79	8,595,892
Ohio	3,765,704	2.26	8,506,725	2,350,838	6.40	15,046,303
Michigan	2,392,617	2.29	5,469,523	720,766	7.16	5,161,405
Indiana	972,345	2.39	2,325,654	1,815,638	6.63	12,033,324
Illinois	1,032,976	2.37	2,450,632	3,422,454	7.01	23,988,664
Wisconsin	1,066,376	2.16	2,304,225	930,228	7.87	7,317,171
Minnesota	514,939	2.19	1,128,129	566,967	7.38	4,184,216
Iowa	775,222	2.59	2,004,724	5,996,179	8.24	49,403,718
Missouri	1,000,953	1.91	1,914,023	3,709,517	4.86	18,035,671
Kansas	323,392	1.97	635,789	2,249,714	6.83	15,364,873
Nebraska	277,952	2.31	643,014	2,088,964	8.05	16,811,981
South Dakota	336,960	2.25	759,642	241,643	7.50	1,812,081
North Dakota	370,880	2.03	754,073	99,275	6.59	654,226
Montana	2,780,908	1.76	4,891,895	39,388	9.22	363,036
Wyoming	1,198,567	2.17	2,606,284	15,834	6.73	106,530
Colorado	1,293,658	1.85	2,396,295	26,021	7.39	192,424
New Mexico	2,921,188	1.26	3,689,169	27,521	7.43	204,590
Arizona	691,246	1.75	1,209,681	19,536	7.25	141,636
Utah	1,905,819	1.63	3,098,480	51,850	8.46	438,887
Nevada	544,077	2.14	1,164,162	11,590	8.75	101,366
Idaho	779,547	2.25	1,753,981	58,725	8.15	478,609
Washington	832,063	2.39	1,989,796	162,977	5.51	897,678
Oregon	2,529,759	1.75	4,433,403	210,747	4.65	979,805
California	3,918,157	1.81	7,074,625	435,663	5.57	2,427,342
Oklahoma	18,222	2.10	38,266	24,158	5.25	126,830
Total	45,048,017	1.98	89,186,110	45,206,498	5.98	270,384,626

PRODUCTION OF HONEY AND BEESWAX.

The census returns for the production of honey and beeswax for 1889, having been furnished through the courtesy of that office, a tabular statement is published herewith, giving the production by States. The figures for 1879 and 1869, from the same source, are also shown for the purposes of comparison. A hasty analysis of the table shows a much greater increase in the production of honey than of wax. It shows also that the increase in the production of the former was much greater between 1879 and 1889 than between 1869 and 1879, whereas, with respect to wax, the reverse is true. The increase of the latter product between 1879 and 1889 (5·5 per cent) seems out of proportion when compared with that of honey, which was 148·2 per cent. This can be accounted for in a measure by the improved methods of apiculture, and especially by the more general use of the extractor, which greatly increases the product of honey per hive, while it dis-

courages the building of comb. The percentage of increase of 1879 over 1869 was, honey, 75·1; wax, 75·2 per cent.

The table shows wonderful advancement in this industry during the last decade. In 1879 but 12 States produced more than a million pounds of honey each, and but 2 more than 2,000,000 each, while in 1889 there were 20 that produced more than 1,000,000 each. Of these Iowa produced nearly 7,000,000 pounds; 3 others, Illinois, Missouri, and New York, in the order named, produced above 4,000,000 pounds; 3 more, led by California, above 3,000,000 pounds; 7 above 2,000,000, and 6 above 1,000,000 pounds.

The honey crop is known to be one of the most variable, honey secretion in the plant being uncertain, and success depending largely upon favorable weather for gathering during the short period of harvest. The relative success of the years 1879 and 1889 the office has no means of determining, but, making allowance for this factor, which may or may not favor the deduction, and taking into consideration, also, the increased yield per hive under the improved methods of culture, it would seem that the industry was being rapidly extended.

Crops of beeswax and honey, 1869, 1879, 1889.

States and Territories.	1869.		1879.		1889.	
	Beeswax.	Honey.	Beeswax.	Honey.	Beeswax.	Honey.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Maine	5, 253	155, 640	4, 770	198, 499	4, 119	260, 481
New Hampshire	2, 668	56, 944	2, 856	87, 886	1, 674	112, 114
Vermont	5, 235	142, 932	4, 574	221, 729	5, 793	379, 096
Massachusetts	1, 195	25, 299	2, 463	49, 397	1, 690	90, 929
Rhode Island	498	6, 299	536	8, 397	358	13, 740
Connecticut	1, 326	32, 158	3, 543	100, 378	3, 683	130, 632
New York	86, 333	896, 286	79, 756	2, 088, 845	66, 654	4, 281, 964
New Jersey	2, 021	60, 636	6, 145	131, 342	3, 381	160, 310
Pennsylvania	27, 033	796, 989	46, 610	1, 415, 093	39, 877	2, 453, 424
Delaware	800	33, 151	2, 151	76, 234	1, 612	66, 468
Maryland	3, 439	118, 938	7, 722	283, 752	5, 946	301, 157
Virginia	26, 438	505, 239	53, 200	1, 090, 451	44, 114	1, 531, 147
North Carolina	109, 054	1, 404, 040	126, 268	1, 591, 590	126, 447	2, 373, 560
South Carolina	11, 404	194, 253	26, 780	354, 350	27, 739	856, 688
Georgia	31, 233	610, 877	69, 318	1, 056, 034	49, 935	1, 757, 758
Florida	6, 052	50, 884	17, 976	211, 934	27, 083	562, 986
Alabama	22, 767	320, 674	66, 876	841, 535	68, 884	1, 824, 286
Mississippi	9, 390	199, 581	24, 249	382, 560	21, 962	822, 673
Louisiana	2, 363	37, 646	11, 736	168, 441	8, 584	271, 962
Texas	13, 255	275, 169	35, 825	761, 225	62, 509	3, 286, 386
Arkansas	12, 789	276, 824	42, 354	1, 012, 721	24, 811	1, 111, 246
Tennessee	51, 685	1, 039, 550	86, 421	2, 130, 689	63, 290	2, 284, 155
West Virginia	9, 917	376, 997	26, 667	833, 564	22, 109	1, 218, 686
Kentucky	32, 557	1, 171, 500	46, 912	1, 500, 565	37, 225	2, 310, 615
Ohio	22, 488	763, 124	56, 333	1, 626, 847	33, 520	2, 894, 059
Michigan	14, 571	280, 325	32, 088	1, 028, 595	26, 759	2, 487, 134
Indiana	12, 049	395, 278	31, 637	967, 581	24, 864	2, 106, 817
Illinois	46, 262	1, 547, 178	45, 640	1, 310, 138	50, 420	4, 602, 941
Wisconsin	9, 945	299, 341	22, 960	813, 806	46, 058	3, 515, 761
Minnesota	3, 963	92, 606	6, 552	234, 054	12, 050	1, 160, 390
Iowa	2, 225	853, 213	39, 565	1, 310, 138	67, 339	6, 813, 412
Missouri	35, 248	1, 156, 444	45, 462	721, 080	75, 670	4, 492, 178
Kansas	2, 208	110, 827	6, 951	201, 034	8, 880	890, 913
Nebraska	707	28, 114	1, 828	86, 645	6, 262	746, 212
South Dakota	6	110	27	6, 180	1, 563	55, 833
North Dakota	....	....	....	....	8	990
Montana	....	....	....	....	....	20
Wyoming	....	....	....	....	....	350
Colorado	....	....	96	8, 340	7, 901	390, 906
New Mexico	....	....	5	450	98	21, 470
Arizona	....	....	10	650	668	126, 124
Utah	13	575	1, 546	87, 331	11, 708	479, 153
Nevada	....	363	60	24, 296	2, 825	88, 557
Idaho	....	....	....	....	....	37, 146
Washington	620	25, 636	972	20, 005	2, 957	156, 435
Oregon	1, 207	66, 858	3, 444	122, 348	7, 272	435, 028
California	4, 903	294, 326	14, 672	574, 029	60, 237	3, 929, 889
Total	631, 129	14, 702, 815	1, 105, 556	25, 741, 485	1, 166, 543	63, 894, 186

POULTRY AND EGGS.

An enumeration of poultry and poultry products in the United States was attempted for the first time in the census of 1880. As then reported, there were in the United States in 1880, exclusive of spring hatching, 102,265,653 barnyard fowl (chickens), and 23,234,687 other domestic fowl, such as geese, ducks, and turkeys. The number of dozens of eggs produced during the year 1879 was 456,875,080. The figures of the Eleventh Census, just issued, make the number of barnyard fowl for the year 1890, 258,472,155; that of turkeys, geese, and ducks, 26,816,545; and the number of dozens of eggs produced during 1889, 817,211,146. This shows during the decade under consideration an increase in the number of barnyard fowl of 153 per cent, of other fowl, 15 per cent, and in the number of eggs produced of 79 per cent. At 12 cents a dozen, a very moderate estimate, the annual value of the egg product on the farm rose from $55,000,000 in 1879 to $98,000,000 in 1889. If in addition to this the annual consumption of meat sold from the poultry reported is considered, the importance of this branch of rural industry will be more fully appreciated.

Poultry and egg products, 1879–'80 and 1889–'90.

States and Territories.	1879–'80.			1889–'90.		
	Poultry on hand June 1, 1880, exclusive of spring hatching.		Eggs produced in 1879.	Poultry on hand June 1, 1890.		Eggs produced in 1889.
	Barnyard.	Other.		Domestic fowl (chickens).	Other.	
	Number.	*Number.*	*Dozens.*	*Number.*	*Number.*	*Dozens.*
Maine	944, 993	53, 748	7, 059, 876	1, 411, 185	49, 476	9, 384, 252
New Hampshire	486, 127	20, 683	3, 347, 211	934, 322	30, 033	5, 049, 150
Vermont	517, 992	49, 836	3, 050, 131	789, 278	96, 049	4, 515, 130
Massachusetts	914, 327	48, 594	6, 571, 553	1, 623, 605	84, 777	8, 931, 398
Rhode Island	245, 070	24, 689	1, 564, 934	482, 370	42, 167	2, 020, 714
Connecticut	736, 703	45, 934	5, 209, 061	1, 075, 044	66, 760	5, 637, 590
New York	6, 448, 886	496, 406	31, 958, 739	8, 421, 667	784, 464	49, 807, 106
New Jersey	1, 188, 492	285, 073	6, 686, 142	2, 990, 698	296, 305	8, 031, 571
Pennsylvania	6, 620, 016	740, 787	34, 377, 889	10, 381, 781	999, 604	50, 049, 915
Delaware	268, 692	96, 207	1, 427, 087	900, 212	131, 149	2, 218, 754
Maryland	1, 060, 800	396, 925	4, 984, 776	3, 430, 859	602, 279	8, 718, 593
Virginia	1, 987, 010	660, 147	8, 950, 629	6, 576, 260	992 731	13, 557, 571
North Carolina	2, 071, 616	897, 840	7, 455, 132	7, 507, 593	742, 820	11, 755, 635
South Carolina	1, 107, 954	309, 675	3, 416, 846	3, 873, 798	407, 750	5, 702, 141
Georgia	2, 266, 446	1, 176, 137	7, 126, 058	7, 357, 934	546, 010	11, 522, 788
Florida	439, 220	104, 860	1, 024, 106	919. 601	81, 419	2, 788, 991
Alabama	2, 099, 733	916, 966	6, 761, 646	6, 252, 044	661, 757	10, 823, 526
Mississippi	1, 935, 775	961, 958	6, 364, 410	5, 631, 784	732, 813	11, 393, 498
Louisiana	1, 113, 342	377, 565	3, 392, 246	2, 246, 907	291, 104	5, 933, 700
Texas	3, 127, 770	1, 168, 097	11, 486, 566	11, 523, 717	1, 455, 151	32, 466, 433
Arkansas	1, 829, 856	881, 706	6, 610, 050	6, 264, 427	783, 678	13, 371, 909
Tennessee	3, 482, 267	1, 922, 454	16, 347, 482	12, 062, 139	1, 570, 445	23, 172, 313
West Virginia	1, 321, 886	285, 315	6, 741, 893	3, 197, 447	525, 421	8, 446, 259
Kentucky	3, 577, 023	2, 399, 042	15, 812, 205	12, 740, 559	2, 009, 924	24, 691, 437
Ohio	8, 780, 846	1, 159, 081	43, 092, 291	13, 659, 359	1, 008, 094	70, 162, 240
Michigan	3, 859, 581	227, 433	20, 762, 171	5, 852, 690	357, 534	34, 209, 633
Indiana	5, 756, 643	1, 091, 368	28, 823, 819	12, 307, 903	1, 287, 890	48, 621, 660
Illinois	9, 910, 806	1, 615, 165	35, 978, 297	21, 463, 525	2, 505, 511	60, 351, 965
Wisconsin	3, 561, 353	294, 373	15, 826, 025	5, 646, 294	427, 518	29, 390, 784
Minnesota	2, 098, 824	159, 561	8, 234, 161	4, 448, 831	295, 380	20, 354, 498
Iowa	7, 550, 508	989, 206	32, 553, 933	20, 201, 706	1, 749, 567	69, 448, 339
Missouri	6, 810, 068	2, 096, 085	28, 352, 032	22, 785, 848	2, 405, 940	53, 147, 418
Kansas	3, 651, 256	746, 226	17, 432, 286	15, 843, 345	1, 133, 410	42, 584, 975
Nebraska	1, 648, 044	191, 048	7, 166, 090	7, 395, 368	563, 655	23, 300, 684
South Dakota	278, 262	24, 229	1, 012, 613	2, 292, 866	131, 260	8, 777, 993
North Dakota				804, 388	55, 113	3, 552, 664
Montana	58, 224	2, 160	208, 794	233, 669	9, 992	834, 166
Wyoming	10, 431	736	30, 740	73, 604	4, 293	332, 221
Colorado	121, 327	22, 477	520, 820	710, 942	34, 073	2, 685, 109

Poultry and egg products, 1879–'80, and 1889–'90—Continued.

States and Territories.	1879–'80.			1889–'90.		
	Poultry on hand June 1, 1880, exclusive of spring hatching.		Eggs produced in 1879.	Poultry on hand June 1, 1890.		Eggs produced in 1889.
	Barnyard.	Other.		Domestic fowl (chickens).	Other.	
	Number.	*Number.*	*Dozens.*	*Number.*	*Number.*	*Dozens.*
New Mexico	40,769	8,530	238,853	60,596	2,248	279,664
Arizona	20,844	1,706	72,534	57,224	4,586	204,174
Utah	214,733	7,883	826,237	279,983	16,326	1,131,071
Nevada	36,710	6,925	120,471	62,167	7,436	170,725
Idaho	65,397	20,624	268,731	231,547	15,176	737,812
Washington	137,581	9,548	501,448	779,972	37,156	2,710,520
Oregon	435,392	55,503	1,654,738	1,180,765	97,269	4,453,933
California	1,425,991	184,176	5,771,323	3,504,250	482,952	13,679,423
Total	102,265,653	23,234,687	456,875,080	258,472,155	26,816,545	817,211,146

DAIRY PRODUCTS.

Returns of the Eleventh, Tenth, and Ninth censuses relating to the production of milk, butter, and cheese on the farm are presented in detail by States in the table below. The statement shows a marked increase in the production of milk and butter and an equally marked decrease in the production of cheese. In milk the percentage of increase, 1889 over 1879, was 883·2; 1879 over 1869, 125; in butter, 1889 over 1879, 31·7 per cent; 1879 over 1869, 51·2 per cent. The outturn of cheese in 1889 showed a decrease of 31·3 per cent from that of 1879, and in 1879 a decrease of 49 per cent from 1869.

The production of milk has apparently made greater proportional gains than the production of its products, but it must be remembered that while the figures for milk represent practically the total product, the figures for butter and cheese are exclusive of the output of creameries and factories.

The manufacture of cheese is being relegated more and more to the factory, and only in a few States, principally in the mountain and Pacific coast districts, is there indicated an increased production on the farm. In the States of largest production the product of 1889 is but one-half that of 1879.

Notwithstanding the rapid extension of the creamery system in the decade 1879 to 1889, the production of butter on the farm is shown to be still on the increase. In the Eastern States, however, the outturn has remained about stationary since 1879. A most remarkable advance has been made in the Southern and south central States. Good gains, but less, proportionally, will be noted in States north of the Ohio and east of the Mississippi rivers. An increase approximating 100 per cent is shown in the figures for the Pacific States.

Dairy products produced on farms in 1869, 1879, 1889.

States and Territories.	Butter, cheese, and milk produced on farms in— 1869. Butter.	Cheese.	Milk.
	Pounds.	*Pounds.*	*Gallons.*
Maine	11, 636, 482	1, 152, 590	1, 374, 091
New Hampshire	5, 965, 080	849, 118	2, 352, 884
Vermont	17, 844, 396	4, 830, 700	3, 835, 840
Massachusetts	6, 559, 161	2, 245, 873	15, 284, 057
Rhode Island	941, 199	81, 976	1, 944, 044
Connecticut	6, 716, 007	2, 031, 194	6, 253, 259
New York	107, 147, 526	22, 769, 964	135, 775, 919
New Jersey	8, 266, 023	38, 229	5, 373, 323
Pennsylvania	60, 834, 644	1, 145, 209	14, 411, 729
Delaware	1, 171, 963	315	758, 603
Maryland	5, 014, 729	6, 732	1, 520, 101
Virginia	6, 979, 269	71, 743	266, 812
North Carolina	4, 297, 834	75, 185	17, 145
South Carolina	1, 461, 980	169	241, 815
Georgia	4, 499, 572	4, 292	109, 139
Florida	100, 989	25	3, 002
Alabama	3, 213, 753	2, 732	104, 657
Mississippi	2, 613, 521	3, 039	17, 052
Louisiana	322, 405	11, 747	833, 928
Texas	3, 712, 747	34, 342	62, 771
Arkansas	2, 753, 931	2, 119	31, 350
Tennessee	9, 571, 069	142, 240	415, 786
West Virginia	5, 044, 475	32, 429	144, 895
Kentucky	11, 874, 978	115, 219	1, 345, 779
Ohio	50, 266, 372	8, 169, 486	22, 275, 344
Michigan	24, 400, 185	670, 804	2, 277, 122
Indiana	22, 915, 385	283, 807	936, 983
Illinois	36, 083, 405	1, 661, 703	9, 258, 545
Wisconsin	22, 473, 036	1, 591, 798	2, 059, 105
Minnesota	9, 522, 010	233, 977	208, 130
Iowa	27, 512, 179	1, 087, 741	688, 800
Missouri	14, 455, 825	204, 090	857, 704
Kansas	5, 022, 758	226, 607	196, 662
Nebraska	1, 539, 535	46, 142	95, 059
South Dakota North Dakota	209, 735	1, 850	....
Montana	408, 080	25, 603	105, 186
Wyoming	1, 200	....	4, 980
Colorado	392, 920	33, 626	19, 520
New Mexico	12, 912	27, 239	813
Arizona	800	14, 500	4, 800
Utah	310, 335	69, 603	11, 240
Nevada	110, 880	....	63, 850
Idaho	111, 480	4, 464	11, 250
Washington	407, 306	17, 465	21, 060
Oregon	1, 418, 373	79, 333	107, 367
California	7, 969, 744	3, 395, 074	3, 693, 021
Total	514, 088, 138	53, 492, 153	235, 374, 522

Dairy products produced on farms in 1869, 1879, 1889—Continued.

States and Territories.	Butter, cheese, and milk produced on farms in—					
	1879.			1889.		
	Butter.	Cheese.	Milk.	Butter.	Cheese.	Milk.
	Pounds.	*Pounds.*	*Gallons.*	*Pounds.*	*Pounds.*	*Gallons.*
Maine	14,103,966	1,167,730	3,720,783	15,593,315	696,052	57,969,791
New Hampshire	7,247,272	807,076	5,739,128	7,942,840	341,235	42,633,268
Vermont	25,240,826	1,545,789	6,526,550	23,314,063	609,586	90,712,230
Massachusetts	9,655,587	829,528	29,662,953	8,358,703	122,900	82,571,924
Rhode Island	1,007,103	67,171	3,831,706	965,456	24,631	10,610,547
Connecticut	8,198,995	826,195	12,289,893	7,196,095	112,566	54,413,822
New York	111,922,423	8,362,590	231,963,533	98,241,813	4,324,028	663,917,240
New Jersey	9,513,835	66,518	15,472,783	8,367,218	23,613	64,003,953
Pennsylvania	79,336,012	1,008,686	36,540,540	76,809,041	439,060	368,906,480
Delaware	1,876,275	1,712	1,132,434	2,026,498	359	10,699,362
Maryland	7,485,871	17,416	4,722,944	9,999,602	9,573	46,601,218
Virginia	11,470,923	85,835	1,224,469	17,949,966	109,187	73,143,459
North Carolina	7,212,507	57,380	446,798	13,129,374	60,760	55,250,665
South Carolina	3,196,851	16,018	257,186	5,737,557	2,476	23,833,631
Georgia	7,424,485	19,151	374,645	14,483,323	12,833	52,234,508
Florida	353,156	2,406	40,967	867,195	1,731	5,056,790
Alabama	7,997,719	14,091	267,387	14,548,435	6,131	55,508,687
Mississippi	7,454,657	4,239	427,492	12,988,637	4,898	50,803,371
Louisiana	916,089	7,618	256,241	2,089,774	3,939	12,881,927
Texas	13,899,320	58,466	1,296,806	32,100,560	145,730	118,475,320
Arkansas	7,790,013	26,301	316,853	15,724,144	21,328	54,325,673
Tennessee	17,886,369	98,740	1,006,795	28,314,387	69,919	107,657,116
West Virginia	9,309,517	100,300	750,279	14,063,627	74,372	59,449,066
Kentucky	18,211,904	58,468	2,513,209	29,038,406	64,822	118,497,289
Ohio	67,634,263	2,170,245	46,801,537	74,990,307	1,068,083	326,925,396
Michigan	38,821,890	440,540	7,898,273	50,197,481	328,682	224,537,488
Indiana	37,377,797	367,561	6,723,840	48,477,766	360,948	200,510,797
Illinois	53,657,943	1,035,069	45,419,719	57,121,486	343,456	367,269,464
Wisconsin	33,353,040	2,281,411	25,156,977	46,295,623	906,266	303,701,134
Minnesota	19,161,385	523,138	1,504,407	34,766,409	676,642	182,968,973
Iowa	55,481,958	1,075,988	15,965,612	72,893,079	1,038,358	486,961,411
Missouri	28,572,124	283,484	3,173,017	43,108,521	288,620	193,931,103
Kansas	21,671,762	483,987	1,360,235	46,117,076	759,210	201,608,099
Nebraska	9,725,198	230,819	625,783	27,818,078	463,831	144,768,263
South Dakota	2,000,955	39,437	415,119	13,127,244	303,951	59,666,525
North Dakota				5,712,566	131,374	26,566,112
Montana	403,738	55,570	41,165	1,062,185	11,512	6,038,006
Wyoming	105,643	2,930	75,343	428,269	15,196	3,064,588
Colorado	860,379	10,867	506,706	3,282,086	87,183	19,680,791
New Mexico	44,827	10,501	10,036	86,042	18,931	717,155
Arizona	61,817	18,360	42,618	115,203	10,855	709,225
Utah	1,052,903	126,727	155,263	1,759,354	163,539	8,614,694
Nevada	335,188	17,420	149,889	489,657	51,207	2,532,052
Idaho	310,644	20,295	15,627	1,078,103	207,213	5,085,863
Washington	1,356,103	109,200	226,703	3,482,225	71,281	19,873,281
Oregon	2,443,725	153,198	227,540	4,786,277	265,576	25,042,276
California	14,084,405	2,566,618	12,353,173	26,776,704	3,871,575	111,191,186
Total	777,229,367	27,272,489	529,632,966	1,023,821,770	18,725,218	5,207,121,309

THE CANNING INDUSTRY.

TOMATO PACK.

The American Grocer issued on January 10, 1894 its annual report of the tomato and corn pack in the United States and Canada. Although drought and other adverse climatic conditions reduced the crop in some sections, the tomato pack turns out to be the heaviest ever recorded, being 32 per cent larger than that of 1892, which was about equal to the average during the last seven years. It reached the grand total of 4,456,443 cases of 2 dozen each, against 3,366,792 cases in 1892, and 3,405,365 cases in 1891. This large output is undoubtedly the result of the sharp advance in prices of canned tomatoes during the first half of 1893, culminating in July, when No. 3 standard grade tomatoes sold from $1.25 to $1.45, as against $1 to $1.15 in January.

This rise was due to the fact that stocks were exhausted at the beginning of the packing season, as importations from England and Canada were necessary in order to satisfy the demand. The situation established a premium on tomato packing, so that every kettle within reach was put in operation. The acreage in some sections, particularly in the West, was increased nearly 50 per cent. On the Atlantic seaboard there was a long period of drought, which damaged the crop to such an extent that the opinion generally prevailed that "there would not be enough of the festive tomato to go around."

As the average consumption in the United States is about 3,300,000 cases, the result is a surprise, showing a surplus of about 1,000,000 cases, a large portion of which will have to be carried over.

The following table shows the pack of 1893 as compared with that of 1892 in cases of 2 dozen each:

Tomato pack (by States) in 1892 and 1893.

	1893.	1892.		1893.	1892.
New Jersey	977, 242	862, 692	Massachusetts	3, 400	6, 557
Maryland	1, 417, 626	977, 742	Kentucky	6, 500	2, 200
Indiana	347, 260	282, 717	Arkansas	14, 000	2, 500
California	451, 547	230, 943	Texas	7, 521	100
Delaware	271, 277	175, 700	North Carolina	7, 350	1, 500
New York	160, 885	146, 290	South Carolina	2, 950	7, 500
Virginia, including West-Virginia, 2,000	45, 020	60, 386	Alabama	2, 200	1, 170
			Georgia	4, 700	12, 400
Iowa	82, 719	57, 500	Minnesota	2, 000	....
Ohio	64, 720	87, 840	Wisconsin	3, 250	....
Missouri	122, 495	64, 621	Mississippi	2, 300	....
Michigan	30, 502	39, 602	Oklahoma Territory	2, 500	....
Illinois	64, 400	42, 200			
Kansas	76, 815	30, 833	Total	4, 300, 443	3, 223, 165
Utah	29, 000	55, 000	Canada	156, 000	143, 627
Nebraska	16, 900	2, 210			
Pennsylvania	24, 364	18, 950	Total United States and Canada	4, 456, 443	3, 366, 792
Connecticut	9, 500	14, 750			
Colorado	49, 500	39, 262			

This estimate shows that the excess in the tomato pack of the United States for 1893 over that of last year is 33 per cent; the excess in Canada is 8 per cent, and for both countries it is 32 per cent. As some factories had not reported when the foregoing estimate was made, these figures represent the minimum quantity packed.

The total output in 1893 compares with the pack of previous years as follows:

Output of tomatoes in years 1887–1893.

Year.	Cases of 2 dozen tins each.
1893	4,456,443
1892	3,366,792
1891	3,405,365
1890	3,166,177
1889	2,976,765
1888	3,343,137
1887	2,817,048
Total for seven years	23,531,727
Average per year	3,361,675
Average per years 1891–1893	3,742,867

The following tables give the monthly and yearly range of prices for No. 3 standard tins in New York, Philadelphia, and Baltimore:

Tomato quotations for 1893.

Month.	New Jersey and Delaware standard.	Philadelphia.	Baltimore.
January	$1.00 to $1.15	$0.97½ to $1.00	$1.00 to $1.10
February	1.10 1.15	1.02½ 1.05	1.10
March	1.15 1.17½	1.02½ 1.05	1.10
April	1.15	1.10 1.15	1.10
May	1.15 1.25	1.12½ 1.15	1.10
June	1.25 1.30	1.20 1.22½	1.10 1.25
July	1.25 1.45	1.25 1.27½	1.25 1.30
August	1.00 1.35	1.30 1.35	.80 .85
September	.95 1.10	.80 .90	.85 .92½
October	1.02½ 1.10	.80 .90	.92½
November	.95 1.10	.87½ .95	.92½ .95
December	1.08 1.10	.95 1.00	.92½ .95

The following table gives the highest and lowest price for standard grade tomatoes, No. 3 tins, in the New York market for eight years:

Year.	Lowest.	Highest.	Year.	Lowest.	Highest.
1893	$0.95	$1.45	1889	$0.82½	$0.88
1892	.82½	1.00	1888	.90	1.05
1891	.80	.85	1887	.95	1.10
1890	.77½	1.00	1886	.88½	1.15

The following table brings into comparison the price of No. 3 standard tomatoes in Philadelphia, on January 1, each year for the past twenty years:

January 1—	Price.	January 1—	Price.
1894	$1.00	1884	$0.80
1893	.95	1883	1.00
1892	$0.75 to .80	1882	1.22
1891	.75 to .80	1881	1.10
1890	.75	1880	1.20
1889	.92½	1879	.90
1888	.97½	1878	1.90
1887	.90	1877	1.70
1886	.90	1876	1.50
1885	.75	1875	1.30

CORN PACK.

The corn pack of the United States and Canada for 1893, according to the same authority, was 4,301,451 cases, an increase of 770,372 cases, or 22 per cent over that of last year. This is the largest corn pack on record, and is liable to reproduce in 1894 the fall in prices that occurred in 1889 as a result of the overproduction of canned corn in 1888.

The corn pack by States for 1893, as compared with that of 1892, is shown in the following table:

Corn pack (by States) in 1892 and 1893.

[Dozens of cases.]

States.	1893.	1892.
Maine	609, 167	727, 167
Maryland and Virginia	540, 057	618, 733
New York	1, 074, 530	805, 509
Illinois	626, 496	464, 500
Indiana	76, 108	53, 552
Iowa	470, 381	310, 315
Ohio	369, 000	210, 143
Nebraska	192, 300	100, 730
Kansas	32, 950	27, 775
Missouri	26, 840	15, 881
Michigan	1, 200	400
Pennsyvania	57, 513	22, 100
Delaware	40, 105	47, 600
Other States	67, 804	52, 785
Total	4, 184, 451	3, 117, 190
Canada	117, 000	13, 889
Total United States and Canada	4, 301, 451	3, 531, 079

The pack of corn in 1893 compares with the output of previous years as follows:

Pack of corn in years 1885–1893.

Years.	Cases.	Years.	Cases.
1893	4, 301, 451	1886	1, 704, 735
1892	3, 531, 079	1885	1, 082, 174
1891	2, 889, 153		
1890	1, 588, 860	Total nine years	22, 660, 650
1889	1, 760, 300	Average per year	2, 517, 850
1888	3, 491, 474	Average per year 1891–1893	3, 573, 894
1887	2, 311, 424		

The following shows the highest and lowest price of New York State corn, standard grade, No. 2 tins, in the New York market, and the comparative prices for seven years:

Prices of corn in New York market for seven years.

Months.	New York State No. 2 corn.		Months.	New York State No. 2 corn.	
January	$1.00 to	$1.10	July	$0.90 to	$1.00
February	.90	1.10	August	.90	1.00
March	1.05	1.10	September	.85	1.10
April	1.05	1.10	October	.90	
May	.95	1.10	November	.80	.90
June	.90	1.00	December	.80	.90

Highest and lowest prices of corn.

Year.	Price.	Year.	Price.
1893	$0.80 to $1.10	1889	$0.50 to $0.90
1892	.95 1.25	1888	.80 1.15
1891	.95 1.20	1887	.95 1.25
1890	.60 1.10	1886	.95 1.30

SALMON PACK.

For twenty-eight years salmon have been canned along the Columbia River. The industry reached its culminating point in 1884, when the Columbia River pack amounted to 656,179 cases. The unrestricted slaughter of this valuable food fish has since that year diminished its numbers to such an extent that a gradual diminution in the pack is noticeable, although certain hatcheries have attempted to arrest this downward tendency by saving the eggs and hatching the young artificially, to be returned to the river. Since 1883 the Alaskan waters have become a valuable field for the salmon packer, the product in 1891 reaching 799,294 cases.

The following table presents by districts the Pacific salmon pack for a series of years ending 1892, as taken from the annual review of the San Francisco Daily Commercial News and Shipping List. The estimate for 1893 is taken from the American Grocer of January 24, 1894.

Pacific coast salmon pack (by years), 1866–1893.

Year.	Columbia River.	Sacramento River.	Outside rivers.	British Columbia.	Alaska.	Totals.
	Cases.	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*
1866	4,000					4,000
1867	18,000					18,000
1868	28,000					28,000
1869	100,000					100,000
1870	150,000					150,000
1871	200,000					200,000
1872	250,000					250,000
1873	250,000					250,000
1874	350,000	2,500				352,500
1875	375,000	3,000				378,000
1876	450,000	8,300	25,600	9,847		493,747
1877	460,000	21,500	24,800	67,387		573,687
1878	460,480	36,500	30,000	113,601		640,101
1879	480,000	31,000	30,000	57,394		598,394
1880	530,000	51,000	37,200	61,300		679,500
1881	551,000	181,200	48,500	175,675		956,375
1882	541,360	200,300	49,000	255,061		1,045,661
1883	629,400	160,000	38,000	243,000	36,000	1,106,400
1884	656,179	81,450	41,350	138,945	54,000	971,924
1885	524,530	48,509	51,750	106,865	74,850	806,495
1886	454,943	39,300	131,100	163,004	120,700	909,047
1887	373,800	36,500	195,400	201,990	190,200	997,890
1888	367,750	58,000	154,000	135,600	427,372	1,142,722
1889	325,500	66,666	199,068	414,400	709,347	1,714,981
1890	433,500	35,006	67,117	409,464	683,332	1,633,419
1891	390,183	4,142	78,305	314,813	799,294	1,576,737
1892	502,800		129,000	236,997	480,000	1,343,797
1893	365,700					1,635,879

NOTE.—The figures in the column headed "Totals" are not in all cases the aggregate of the figures for the same year in the other columns, but as it it not known whether the error is in one of the addends or in the total, the figures are here reproduced as found in the original.

EXPORTS OF CANNED GOODS.

The exports of our canned products to foreign countries for the fiscal year ending June 30, 1893, as compared with each of the preceding four years, are presented in the table appended. It will be noticed that since 1891 there has been a gradual decline in the value of our exports of these products, due chiefly to the decrease in the value of canned beef exported from the United States, though in 1893, as compared with 1892 there is also a considerable decrease in our exports of canned fruits.

Exports of canned products, 1889–1893.

	1889.	1890.	1891.	1892.	1893.
Fish:					
Salmon	$3,364,560	$3,259,344	$2,096,957	$1,738,465	$2,279,625
Other	100,623	143,599	139,392	146,067	166,902
Beef	4,375,213	6,787,193	9,068,906	7,876,454	7,222,824
Fruits	915,341	698,321	703,880	1,558,820	1,137,660
Vegetables	311,254	231,265	286,321	373,068	242,284
Total	9,066,391	11,119,722	12,295,456	11,692,874	11,049,295

AGRICULTURAL EXPORTS AND IMPORTS.

The official records of our foreign commerce for the fiscal year ending June 30, 1893, show a decrease in the value of agricultural products exported, as compared with 1892, by $183,974,851, while the imports of 1893 were less than those of 1892 by $12,969,671.

The subjoined tables show in detail the exports of agricultural products for 1892 and 1893, together with the imports of these products for 1891, 1892, and 1893:

Exports of the products of domestic agriculture for the years ending June 30, 1892 and 1893.

Article.	1892.		1893.	
	Quantity.	Value.	Quantity.	Value.
Animals, living:				
Cattle ... number	394,607	$35,099,095	287,094	$26,032,428
Hogs ... do	31,963	364,081	27,375	397,162
Horses ... do	3,226	611,188	2,967	718,607
Mules ... do	1,965	238,591	1,634	210,278
Sheep ... do	46,960	161,105	37,260	126,394
All other, and fowls	....	24,161	....	43,116
Animal matter:				
Bones, hoofs, horns, and horn tips, strips, and waste	....	218,639	....	319,848
Casings for sausages	....	878,675	....	1,409,280
Eggs ... dozen	183,063	32,374	147,989	33,207
Glue ... pounds	580,815	66,403	736,446	74,723
Grease, grease scraps, and all soap stock	....	1,298,598	....	1,067,723
Hair, and manufactures of	....	370,169	....	459,648
Hides and skins other than furs	....	1,223,895	....	1,497,003
Honey	....	78,048	....	15,115
Oils—				
Lard ... gallons	907,575	496,601	486,864	336,634
Other animal ... do	278,954	144,119	212,266	106,275
Meat products—				
Beef products—				
Beef, canned ... pounds	87,028,084	7,876,454	79,088,453	7,222,824
Beef, fresh ... do	220,554,617	18,053,732	206,294,724	17,754,041
Beef, salted or pickled ... do	70,204,736	3,987,829	58,423,963	3,185,321
Beef, other cured ... do	953,712	92,524	898,920	87,776
Tallow ... do	89,780,010	4,425,630	61,819,153	3,129,059

Exports of the products of domestic agriculture, etc.—Continued.

Article.	1892.		1893.	
	Quantity.	Value.	Quantity.	Value.
Animal matter—Continued.				
Meat products—Continued.				
Mutton ....pounds..	101,463	$9,022	108,214	$9,175
Oleomargarine—				
Imitation butter ....do....	1,610,837	195,587	3,479,322	416,386
The oil ....do....	91,581,703	9,011,889	113,939,363	11,207,250
Pork products—				
Bacon ....pounds..	507,919,830	39,334,933	391,758,175	35,781,470
Hams ....do....	76,856,559	7,757,717	82,178,154	9,933,096
Pork, fresh ....do....	377,746	30,246	912,644	79,317
Pork, salted or cured ....do....	80,336,481	4,792,049	52,459,722	4,116,946
Lard ....do....	460,045,776	33,201,621	365,693,501	34,643,993
Poultry and game	....	13,828	....	17,978
All other meat products	....	1,220,205	....	1,245,466
Dairy products—				
Butter ....pounds..	15,047,246	2,445,878	8,920,107	1,672,690
Cheese ....do....	82,100,221	7,676,657	81,350,923	7,624,648
Milk	....	236,358	....	274,155
Wax, bees ....pounds..	127,470	31,898	77,274	22,048
Wool, raw ....do....	202,456	30,664	91,858	14,808
Total value of animals and animal matter	....	181,730,463	....	171,285,887
Bread and breadstuffs:				
Barley ....bushels..	2,800,075	1,751,445	3,035,267	1,468,843
Bread and biscuits ....pounds..	14,449,625	775,596	14,583,967	752,353
Corn ....bushels..	75,451,849	41,590,460	46,037,274	24,587,511
Corn meal ....barrels..	287,609	919,961	271,155	793,081
Oats ....bushels..	9,425,078	3,842,559	2,380,653	951,920
Oatmeal ....pounds..	20,908,190	555,957	5,762,701	160,660
Rye ....bushels..	12,041,316	11,432,160	1,477,058	1,002,796
Rye flour ....barrels..	4,552	22,461	2,811	10,290
Wheat ....bushels..	157,280,351	161,399,132	117,121,109	93,534,970
Wheat flour ....barrels..	15,196,769	75,362,283	16,620,339	75,493,347
All other breadstuffs and preparations of, used as food	....	1,711,103	....	1,555,883
Total value of bread and breadstuffs.	....	299,363,117	....	200,311,654
Cotton and cotton-seed oil:				
Cotton—				
Sea island ....pounds..	9,074,686	1,591,464	7,983,415	1,758,756
Other unmanufactured ....do....	2,926,145,125	256,869,777	2,204,131,711	187,070,952
Cotton-seed oil ....gallons..	13,859,278	4,982,285	9,462,074	3,927,556
Total value of cotton and coton-seed oil	....	263,443,526	....	192,757,264
Miscellaneous:				
Broom corn	....	218,133	....	163,105
Fruits and nuts—				
Apples, dried ....pounds..	26,042,063	1,288,102	7,966,819	482,085
Apples, green or ripe ....barrels..	938,743	2,407,956	408,014	1,097,967
Fruits, preserved—				
Canned	....	1,558,820	....	1,137,660
Other	....	214,738	....	224,381
All other green, ripe, or dried.	....	1,095,815	....	882,695
Nuts	....	60,684	....	94,902
Hay ....tons..	35,201	582,838	33,084	519,640
Hops ....pounds..	12,604,686	2,420,502	11,367,030	2,695,867
Oil cake and oil-cake meal ....do....	826,398,719	9,713,204	802,416,067	9,688,773
Oils—				
Linseed ....gallons..	112,386	54,020	128,936	54,356
Other vegetable	....	73,731	....	236,101
Seeds—				
Clover ....pounds..	19,532,411	1,636,671	8,276,966	988,809
Cotton ....do....	12,149,261	86,549	4,431,914	35,029
Flaxseed or linseed ....bushels..	3,613,187	3,915,547	1,837,370	2,195,374
Timothy ....pounds..	10,318,074	381,651	7,077,131	504,937
All other	....	231,864	....	269,580
Tobacco—				
Leaf ....pounds..	240,716,150	20,303,245	248,367,258	22,292,704
Stems and trimmings ....do....	14,715,927	366,800	17,715,625	599,195
Vegetables—				
Onions ....bushels..	59,842	58,121	57,610	60,878
Pease and beans ....do....	637,972	945,767	389,913	745,636
Potatoes ....do....	557,022	361,378	845,720	700,032
Canned	....	373,068	....	242,284
All other, including pickles	....	159,811	....	149,167

Exports of the products of domestic agriculture, etc.—Continued.

Article.	1892.		1893.	
	Quantity.	Value.	Quantity.	Value.
Miscellaneous:				
Wine—				
In bottles.....dozen..	14,834	$67,686	11,128	$51,654
Not in bottles.....gallons..	655,795	371,344	708,553	369,893
All other agricultural products.....	.....	5,843,051	.....	4,515,872
Total value of miscellaneous products	.....	54,791,126	.....	50,998,576
RECAPITULATION.				
Animals and animal matter.....	.....	181,730,463	.....	171,285,887
Bread and breadstuffs.....	.....	299,363,117	.....	200,311,654
Cotton and cotton-seed oil.....	.....	263,443,526	.....	192,757,264
Miscellaneous products.....	.....	54,791,126	.....	50,998,576
Total agricultural exports.....	.....	799,328,232	.....	615,353,381
Total exports.....	.....	1,015,732,011	.....	830,876,908
Per cent of agricultural matter.....	.....	78·69	.....	74·05

Imports of agricultural products for the years ending June 30, 1891, 1892, and 1893.

Articles.	1891.	1892.	1893.
Sugar and molasses:			
Sugar.....	$105,728,216	$104,408,813	$116,255,784
Molasses.....	2,659,776	2,877,744	1,992,334
Sugar drainings.....	1,349	.....	.....
Total sugar and molasses.....	108,389,341	107,286,557	118,248,118
Tea, coffee, and cocoa:			
Tea.....	13,828,993	14,373,222	13,857,482
Coffee.....	96,123,777	128,041,930	80,485,558
Cocoa, and leaves and shells of.....	3,323,057	3,221,041	4,017,801
Unenumerated items.....	97,794	122,578	183,669
Total tea, coffee, and cocoa.....	113,373,621	145,758,771	98,544,510
Animals and their products, except wool:			
Cattle.....	102,978	47,466	45,682
Horses.....	3,265,254	2,455,868	2,388,267
Sheep.....	1,219,206	1,440,530	1,682,977
All other, and fowls.....	357,927	307,752	525,269
Bristles.....	1,357,938	1,455,058	1,508,258
Butter.....	58,541	16,549	13,479
Cheese.....	1,358,752	1,238,166	1,425,927
Eggs.....	1,185,595	522,240	392,973
Glue.....	497,340	495,519	567,756
Grease.....	430,335	271,421	419,625
Hair.....	2,408,733	1,685,562	2,005,796
Hides.....	27,930,759	26,850,218	27,347,896
Hide cuttings, etc.....	353,943	303,302	365,525
Hoofs, horns, etc.....	587,444	797,529	554,902
Meats—			
Preserved.....	521,322	430,048	558,284
All other.....	144,049	97,883	115,376
Milk.....	105,633	95,947	110,186
Oil, animal.....	5,531	12,136	21,327
Sausage skins.....	572,817	566,650	583,217
Unenumerated.....	813,873	823,964	611,351
Total animals and their products, except wool...	43,277,970	39,913,808	41,244,073
Fibers:			
Animal—			
Wools.....	18,231,372	19,688,108	21,064,180
Silk, unmanufactured.....	19,086,436	25,059,325	29,836,986
Vegetable—			
Cotton.....	2,825,004	3,217,521	4,688,799
Flax.....	1,656,779	1,964,163	1,879,152
Hemp and all substitutes.....	7,949,650	7,354,088	9,061,855
Jute.....	3,862,853	3,021,174	2,467,828

Imports of agricultural products, etc.—Continued.

Articles.	1891.	1892.	1893.
Fibers—Continued.			
Vegetable—Continued.			
Sisal grass and other vegetable substances	$5,829,514	$5,187,620	$6,005,484
Fibers not elsewhere specified	1,987,904	1,597,049	1,957,236
Total fibers	61,429,517	67,089,048	76,961,520
Miscellaneous:			
Breadstuffs—			
Barley	3,222,593	1,592,049	921,605
Corn	1,651	10,752	1,265
Oats	5,056	8,224	8,897
Oatmeal	31,089	27,942	25,642
Rye	98,227	67,597	7,055
Wheat	431,940	1,955,385	707,053
Wheat flour	43,180	4,231	2,223
Breadstuffs and farinaceous substances not elsewhere specified	1,194,473	1,223,066	1,266,835
Chicory	342,517	154,954	208,884
Fruits and nuts	26,015,374	20,968,262	23,689,659
Hay	445,461	715,151	964,755
Hops	1,797,406	883,701	1,085,497
Indigo	1,600,630	1,779,716	3,137,511
Malt, barley	78,433	6,148	4,411
Oils, vegetable			
Fixed or expressed			
Olive	733,489	876,613	891,424
Other	1,465,001	2,239,540	2,754,372
Volatile or essential	1,523,491	1,676,064	1,653,636
Opium, crude	1,202,375	1,029,203	1,186,824
Plants, trees, and shrubs	189,763	155,018	137,503
Rice and rice meal	4,559,540	3,030,883	2,790,151
Seeds	3,266,230	2,264,837	2,757,010
Spices:			
Ground	262,682	307,738	298,068
Unground—			
Nutmegs	686,019	750,813	613,743
Pepper	1,338,637	1,069,268	1,278,062
All other	865,882	920,006	1,110,197
Tobacco, leaf	13,287,094	10,332,423	14,702,440
Vanilla beans	594,744	803,696	703,935
Vegetables:			
Beans and pease	2,078,571	957,824	1,734,228
Potatoes	2,797,927	186,006	2,066,589
Pickles and sauces	511,163	421,292	454,099
All other—			
In their natural state or in salt or brine	1,067,757	563,297	691,968
Prepared or preserved	668,519	754,808	639,805
Wines:			
Champagne and other sparkling	5,615,872	4,571,816	5,579,054
Still wines—			
In casks	2,641,816	2,464,484	2,505,024
In bottles	1,749,372	1,908,203	2,121,275
Unenumerated items	177,523	130,766	152,620
Total miscellaneous	82,591,497	66,811,677	78,891,969
RECAPITULATION.			
Sugar and molasses	108,389,341	107,286,557	118,248,118
Tea, coffee, and cocoa	113,373,621	145,758,771	98,544,510
Animals and their products, except wool	43,277,970	39,913,808	41,244,073
Fibers, animal and vegetable	61,429,517	67,089,048	76,961,520
Miscellaneous	82,591,497	66,811,677	78,891,969
Total agricultural	409,061,946	426,859,861	413,890,190
Total imports	844,916,196	827,402,462	866,400,922
Per cent of agricultural matter	48·4	51·6	47·8

THE SUGAR CROP OF THE WORLD.

BEET SUGAR.

The following table presents Mr. Licht's estimate of the beet-sugar production of Europe for the season 1893–'94 as compared with preceding campaigns:

European beet-sugar production.

Countries.	1893–'94.	1892–'93.	1891–'92.	1890–'91.	1889–'90.	1888–'89.
	Metric tons. *	*Metric tons.* *	*Metric tons.* *	*Metric tons.* *	*Metric tons.* *	*Metric tons.* *
Germany	1,350,000	1,225,331	1,198,156	1,331,965	1,264,607	990,604
Austria-Hungary	845,000	802,577	786,566	778,473	753,078	523,242
France	575,000	588,838	650,377	694,037	787,989	466,767
Russia	650,000	455,000	550,994	544,162	456,711	526,387
Belgium	235,000	196,699	180,377	205,623	221,480	145,804
Holland	75,000	68,070	46,815	76,635	69,765	56,047
Other countries	111,000	92,000	83,635	80,000	80,000	87,000
Total	3,841,000	3,428,515	3,501,920	3,710,895	3,633,630	2,795,851

* One metric ton is equal to 2,204·6 pounds, only a few pounds less than our long ton of 2,240 pounds.

CANE SUGAR.

In regard to this kind of sugar Mr. Licht makes the following estimate for the principal countries which have a surplus for exportation:

Cane-sugar production.

Countries.	1893–'94.	1892–'93.	Countries.	1893–'94.	1892–'93.
	Metric tons.	*Metric tons.*		*Metric tons.*	*Metric tons.*
Cuba	850,000	682,768	Mauritius	125,000	70,732
Puerto Rico	60,000	48,714	Java	480,000	482,007
Trinidad	50,000	50,764	Brazil	260,000	215,000
Barbados	65,000	65,383	Philippine Islands	265,000	273,988
Jamaica	26,000	27,000	United States	265,000	245,000
Martinique	32,000	33,228	Peru	65,000	60,000
Guadeloupe	40,000	41,296	Egypt	70,000	65,000
Lesser Antilles	25,000	25,000	Sandwich Islands	135,000	125,000
Demerara	110,000	99,092			
Réunion	37,000	35,991	Total	2,960,000	2,645,963

According to these estimates the total sugar production of the world for the last five years has been as follows:

Sugar crop of the world.

Years.	Beet sugar.	Cane sugar.	Total.
	Metric tons.	*Metric tons.*	*Metric tons.*
1893–'94	3,841,000	2,960,000	6,801,000
1892–'93	3,428,515	2,645,963	6,074,478
1891–'92	3,501,920	2,852,296	6,354,216
1890–'91	3,710,895	2,554,536	6,265,431
1889–'90	3,633,630	2,069,464	5,703,094

THE WORLD'S SUPPLY AND CONSUMPTION OF COTTON.

All statements purporting to give the crops of the world are necessarily very incomplete, from the fact that for various countries no authentic data are obtainable; and the obstacles to completeness increase when an attempt is made to cover any considerable period. The data given below are obtained partly from official and partly from private publications. Beginning with the United States, the figures on production found in the reports of the several censuses, from the seventh to the eleventh, inclusive, may first be presented. The figures of the last two censuses were published as returns for the years preceding those in which the census was taken, and while those of the three earlier censuses are not so presented in the census reports, they probably relate in the main to the crops of 1849, 1859, and 1869 rather than to those of 1850, 1860, and 1870.

TABLE I.—*Cotton crops of the United States in the last five censuses.*

States and Territories.	1850.*	1860.*	1870.*	1879.		1889.	
				Area.	Product.	Area.	Product.
	Bales.	*Bales.*	*Bales.*	*Acres.*	*Bales.*	*Acres.*	*Bales.*
Alabama	564,429	989,955	429,482	2,330,086	699,654	2,761,165	915,210
Arkansas	65,344	367,393	247,968	1,042,976	608,256	1,700,578	691,494
California			34				
Florida	45,131	65,153	39,789	245,595	54,997	227,370	57,928
Georgia	499,091	701,840	473,934	2,617,138	814,441	3,345,104	1,191,846
Illinois		1,482	465				
Indiana	14		3				
Kansas		61	7			731	212
Kentucky	758		1,080	2,667	1,367	2,629	873
Louisiana	178,737	777,738	350,832	864,787	508,569	1,270,154	659,180
Mississippi	484,292	1,202,507	564,938	2,106,215	963,111	2,883,278	1,154,725
Missouri		41,188	1,246	32,116	20,318	57,260	15,856
Nevada			106				
New Mexico		19					
North Carolina	73,845	145,514	144,935	893,153	389,598	1,147,136	336,261
Oklahoma						1,109	425
South Carolina	300,901	353,412	224,500	1,364,249	522,548	1,987,469	747,190
Tennessee	194,532	296,464	181,842	722,562	330,621	747,471	190,579
Texas	58,072	431,463	350,628	2,178,435	805,284	3,934,525	1,471,242
Utah		136	22				
Virginia	3,947	12,727	183	45,040	19,595	39,213	5,375
West Virginia			2				
United States	2,469,093	5,387,052	3,011,996	†14,480,019	†5,755,359	‡20,175,270	‡7,472,511

* The figures in these three columns probably relate mainly, if not wholly, to the crops of 1849, 1859, and 1869, respectively. See text preceding the table.
† Including 25,000 acres and 17,000 bales in Indian Territory.
‡ Including 70,078 acres and 34,115 bales in Indian Territory.

The annual estimates of the Department of Agriculture began soon after the close of the war. In October, 1866, the crop was estimated by the Statistician at 1,835,000 bales, an estimate subsequently modified to 1,750,000. The estimates for 1867, 1868, and 1869, were as given below:

Year.	Area.	Product.	Value.
	Acres.	*Bales.*	
1867	7,000,000	2,450,000	$220,000,000
1868	7,000,000	2,500,000	225,000,000
1869	7,750,000	3,000,000	303,000,000

The estimates of the Department on area and value for the years from 1870 to 1888, inclusive, are given in Table II below, but the report for 1874 contains no estimate of area and the reports for 1877 and 1882 contain no estimate of value. No estimates have been made by the Department since 1888. All the figures in Table II except those on area are found on page 218 of the Statistical Abstract of the United States for 1893. The figures on quantity produced presented in the same table were taken for the Statistical Abstract from the records of the commercial movement of cotton, which may be presumed to give a more accurate measure of the respective crops than could be obtained from any other source short of an actual census.

TABLE II.—*Crops of the United States from 1870 to 1892 inclusive.*

Years.	Area.*	Annual crops.†	Average net weight of bales.‡	Average gross weight of bales.§	Crop in pounds gross weight.	Farm value.‖
1	2	3	4	5	6	7
	Acres.	*Bales.*	*Pounds.*	*Pounds.*	*Pounds.*	
1870	8,680,000	4,347,006	438	464·85	2,020,693,736	$286,000,000
1871	7,378,000	2,974,351	439	465·34	1,384,084,494	288,300,000
1872	8,500,000	3,930,508	440	466·40	1,833,188,931	301,037,500
1873	9,350,000	4,170,388	439	465·34	1,940,648,352	312,480,000
1874	....	3,827,845	439	465·97	1,783,644,032	256,215,000
1875	10,803,030	4,632,313	436	465·85	2,157,958,142	272,936,400
1876	11,677,250	4,474,069	439	468·45	2,095,901,297	229,444,600
1877	12,000,000	4,773,865	450	473·47	2,260,285,666	205,000,000
1878	12,266,800	5,074,155	443	473·85	2,404,410,373	193,854,641
1879	12,595,500	5,761,252	453	481·11	2,771,797,156	242,140,987
1880	15,475,300	6,605,750	456	484·40	3,199,822,682	280,266,242
1881	16,710,730	5,456,048	446	474·38	2,588,240,050	259,016,315
1882	16,276,691	6,949,756	460	489·95	3,405,070,410	309,696,500
1883	16,777,993	5,713,200	452	482·66	2,757,544,422	250,594,750
1884	17,439,612	5,706,165	451	480·70	2,742,966,011	253,993,385
1885	18,300,865	6,575,691	455	483·95	3,182,305,659	269,989,812
1886	18,454,603	6,505,087	455	485·37	3,157,378,443	257,295,327
1887	18,641,067	7,046,833	458	488·05	3,439,172,391	291,045,346
1888	19,058,591	6,938,290	467	495·79	3,439,934,799	292,139,209
1889	....	7,311,322	477	496·13	3,627,366,183	308,424,271
1890	....	8,652,597	477	498·81	§4,316,043,982	350,000,000
1891	....	9,035,379	476	498·77	§4,506,575,984	313,000,000
1892	....	6,700,365	472	500·37	§3,352,658,458	268,000,000

* Estimates of the Department of Agriculture as published from year to year in its reports. (*See* text above.)

† The amounts given as annual crop represent the commercial movement for periods of twelve months beginning on September 1 of the year in which the crop was grown. The statistical abstract makes acknowledgments for the figures on this subject to the New York Shipping and Commercial List, the New York Commercial and Financial Chronicle, the National Cotton Exchange and the New Orleans Cotton Exchange.

‡ As reported by Mr. Thomas Ellison, of Liverpool.

§ As reported by Henry A. Hester, secretary New Orleans Cotton Exchange.

‖ The figures in this column are mainly the estimates of the Department of Agriculture. (*See* text above.)

The commercial movement from September 1, 1893, to April 30, 1894, indicates that the crop of 1893 was considerably larger than that of 1892. The total supply brought into sight out of the crop of 1893 from September 1, 1893, to April 30, 1894, inclusive, as stated by the secretary of the New Orleans Cotton Exchange, was 7,101,386 bales, against 6,272,542 bales during the corresponding portion of 1892-'93.

The figures given below in Table III are from page 218 of the Statistical Abstract of the United States for 1893. Those in columns 2 and 3 combined make the total crop in pounds, as given in column 6, Table II. It must be borne in mind, however, that the exports for each fiscal year are out of the crop of the calendar year preceding that in which

the fiscal year closes, and that consequently 1871, in column 1, Table III, corresponds to 1870, in column 1, Table II, and so on for the succeeding years.

TABLE III.—*Exports, imports, and domestic consumption of cotton in the United States.*

Years ending June 30—	Exports of domestic.	Domestic retained for consumption.	Imports.	Exports of foreign.	Foreign retained for consumption.	Total consumption, domestic and foreign.	Per cent of domestic product exported.
1	2	3	4	5	6	7	8
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
1871	1,462,928,024	557,765,712	1,196,840	776,483	420,357	558,186,069	72·39
1872	933,537,413	450,547,081	2,894,183	288,297	2,605,886	453,152,967	67·44
1873	1,200,063,530	633,125,401	4,425,524	334,648	4,090,876	637,216,277	65·47
1874	1,358,602,303	582,046,049	3,625,830	377,610	3,248,220	585,294,269	70·03
1875	1,260,418,903	523,225,129	2,149,332	433,041	1,716,291	524,941,420	70·69
1876	1,491,405,334	666,552,808	2,451,419	224,497	2,226,922	668,779,730	70·75
1877	1,445,369,130	650,532,167	2,656,567	277,949	2,378,618	652,910,785	68·97
1878	1,607,533,511	652,752,155	3,032,013	935,541	2,096,472	654,848,627	71·23
1879	1,628,372,833	776,037,540	2,993,677	503,146	2,490,531	778,528,071	67·74
1880	1,822,061,114	949,736,042	3,547,792	234,729	3,313,063	953,049,105	65·73
1881	2,191,928,772	1,007,893,910	4,449,866	1,240,576	3,209,290	1,011,103,200	68·47
1882	1,739,975,961	848,264,089	4,339,952	1,843,490	2,496,462	850,760,551	67·23
1883	2,283,075,062	1,116,995,348	4,081,945	3,238,930	843,015	1,117,838,363	67·20
1884	1,862,572,530	894,971,892	7,019,492	1,353,936	5,665,556	900,637,448	67·56
1885	1,891,659,472	851,306,539	5,115,680	1,609,260	3,506,420	854,812,959	68·96
1886	2,058,037,444	1,124,268,215	5,072,334	1,276,961	3,795,373	1,128,063,588	64·68
1887	2,169,457,330	987,921,113	3,924,531	716,371	3,208,160	991,129,273	68·71
1888	2,264,120,826	1,175,051,565	5,497,592	203,972	5,293,620	1,180,345,185	65·83
1889	2,384,816,669	1,055,118,130	7,973,039	187,959	7,785,080	1,062,903,210	69·33
1890	2,471,799,853	1,155,566,330	8,606,049	248,104	8,357,945	1,163,924,275	68·15
1891	2,907,358,795	1,408,685,187	20,908,817	447,794	20,461,023	1,429,146,210	67·36
1892	2,935,219,811	1,571,356,173	28,663,769	132,777	28,530,992	1,599,887,165	65·13
1893	2,212,115,126	1,140,543,332	43,367,952	360,832	43,007,120	1,183,550,452	65·99

The figures in the following table for the years from 1870–'71 to 1889–'90, inclusive, are found on page 138 of Latham and Alexander's Cotton Movement and Fluctuations for 1892. Those from 1890–'91 to 1892–'93, inclusive, are found, as also are the others, with two exceptions*, on page 405 of the Commercial and Financial Chronicle of September 9, 1893. The quantities are expressed in bales of 400 pounds. The figures for the United States, when reduced to pounds, differ more or less from those given in Table II, but the table as a whole may serve to give an approximate idea of that portion of the world's cotton crop which enters into the commercial supply of Europe and our own country, with the parts thereof contributed by the United States and by other countries, respectively:

* In the Commercial and Financial Chronicle the visible supply at the end of 1889–'90 is stated at 1,120,000, and the invisible at 314,000 bales.

TABLE IV.—*Supply and distribution of cotton.*

[Bales of 400 pounds each.]

Years.	Visible and invisible beginning of year.	Crops.			Total actual consumption.*	Balance of year's supply.		
		United States.	Supply of other countries.	Total.		End of year.		Burnt, etc.
						Visible.	Invisible.	
1870–'71	1,725,000	4,733,000	2,025,000	6,758,000	5,820,000	1,696,000	882,000	85,000
1871–'72	2,578,000	3,241,000	3,036,000	6,277,000	6,312,000	1,785,000	668,000	90,000
1872–'73	2,453,000	4,283,000	2,083,000	6,366,000	6,425,000	1,591,000	729,000	74,000
1873–'74	2,320,000	4,597,000	2,320,000	6,917,000	6,632,000	1,682,000	843,000	80,000
1874–'75	2,525,000	4,216,000	2,309,000	6,525,000	6,656,000	1,619,000	705,000	70,000
1875–'76	2,324,000	5,171,000	2,018,000	7,189,000	7,082,000	1,732,000	614,000	85,000
1876–'77	2,346,000	4,933,000	1,897,000	6,830,000	7,140,000	1,318,000	643,000	75,000
1877–'78	1,961,000	5,425,000	1,506,000	6,931,000	7,272,000	1,214,000	326,000	80,000
1878–'79	1,540,000	5,637,000	1,398,000	7,035,000	7,223,000	1,068,000	199,000	85,000
1879–'80	1,267,000	6,556,000	1,894,000	8,450,000	8,081,000	1,499,000	49,000	88,000
1880–'81	1,548,000	7,519,000	1,837,000	9,356,000	8,646,000	1,922,000	246,000	90,000
1881–'82	2,168,000	6,073,000	2,510,000	8,583,000	9,035,000	1,362,000	254,000	100,000
1882–'83	1,616,000	8,058,000	2,350,000	10,408,000	9,499,000	1,704,000	701,000	120,000
1883–'84	2,405,000	6,485,000	2,434,000	8,919,000	9,290,000	1,505,000	434,000	95,000
1884–'85	1,939,000	6,420,000	2,007,000	8,427,000	8,597,000	1,230,000	449,000	90,000
1885–'86	1,679,000	7,480,000	2,100,000	9,580,000	9,371,000	1,210,000	590,000	88,000
1886–'87	1,800,000	7,450,000	2,478,000	9,928,000	9,757,000	1,248,000	593,000	130,000
1887–'88	1,841,000	8,000,000	2,100,000	10,100,000	10,167,000	965,000	649,000	160,000
1888–'89	1,614,000	8,079,000	2,350,000	10,429,000	10,524,000	902,000	597,000	120,000
1889–'90	1,499,000	8,525,000	2,580,000	11,105,000	11,055,000	1,140,000	294,000	115,000
1890–'91	1,434,000	10,170,000	2,488,000	12,658,000	11,726,000	1,706,000	560,000	100,000
1891–'92	2,266,000	10,800,000	2,390,000	13,190,000	11,816,000	2,933,000	607,000	100,000
1892–'93	3,540,000	8,044,000	2,600,000	10,644,000	11,470,000	2,400,000	263,000	50,000

* Consumption in Europe and the United States.
† This column covers cotton exported to countries not covered by figures of consumption, and cotton burnt in United States, on sea, and in Europe.

To illustrate the preceding, take the last season, 1892–'93, and the results would be as follows:

SUPPLY.

Visible and invisible stock beginning of year		3,540,000
Total crop during year		10,644,000
Total supply (bales of 400 pounds)		14,184,000

DISTRIBUTION.

Total consumption	11,471,000	
Burnt, etc., during the year	50,000	
		11,521,000
Leaving visible stock	2,400,000	
Leaving invisible stock	263,000	
Total visible and invisible stocks at end of year		2,663,000

The following table, which is obtained from the same sources as Table IV, shows how the consumption of cotton exhibited in that table is distributed between Great Britain and the continent in Europe and between the North and South in the United States:

TABLE V.—*Consumption of cotton in Europe and in the United States.*
[Bales of 400 pounds each.]

Year.	Europe.			United States.			Aggregate.
	Great Britain.	Continent.	Total.	North.	South.	Total.	
1870–'71	2, 805, 000	1, 906, 000	4, 711, 000	1, 009, 000	100, 000	1, 109, 000	5, 820, 000
1871–'72	3, 015, 000	2, 057, 000	5, 072, 000	1, 108, 000	132, 000	1, 240, 000	6, 312, 000
1872–'73	3, 084, 000	2, 032, 000	5, 116, 000	1, 157, 000	152, 000	1, 309, 000	6, 425, 000
1873–'74	3, 128, 000	2, 064, 000	5, 192, 000	1, 299, 000	141, 000	1, 440, 000	6, 632, 000
1874–'75	3, 088, 000	2, 240, 000	5, 328, 000	1, 169, 000	159, 000	1, 328, 000	6, 656, 000
1875–'76	3, 176, 000	2, 403, 000	5, 579, 000	1, 344, 000	159, 000	1, 503, 000	7, 082, 000
1876–'77	3, 183, 000	2, 378, 000	5, 561, 000	1, 418, 000	161, 000	1, 579, 000	7, 140, 000
1877–'78	3, 038, 000	2, 509, 000	5, 547, 000	1, 558, 000	167, 000	1, 725, 000	7, 272, 000
1878–'79	2, 843, 000	2, 596, 000	5, 439, 000	1, 615, 000	169, 000	1, 784, 000	7, 223, 000
1879–'80	3, 350, 000	2, 750, 000	6, 100, 000	1, 779, 000	202, 000	1, 981, 000	8, 081, 000
1880–'81	3, 572, 000	2, 956, 000	6, 528, 000	1, 884, 000	234, 000	2, 118, 000	8, 646, 000
1881–'82	3, 640, 000	3, 198, 000	6, 838, 000	1, 931, 000	266, 000	2, 197, 000	9, 035, 000
1882–'83	3, 744, 000	3, 380, 000	7, 124, 000	1, 993, 000	382, 000	2, 375, 000	9, 499, 000
1883–'84	3, 666, 000	3, 380, 000	7, 046, 000	1, 865, 000	379, 000	2, 244, 000	9, 290, 000
1884–'85	3, 433, 000	3, 255, 000	6, 688, 000	1, 608, 000	301, 000	1, 909, 000	8, 597, 000
1885–'86	3, 628, 000	3, 465, 000	7, 093, 000	1, 890, 000	388, 000	2, 278, 000	9, 371, 000
1886–'87	3, 694, 000	3, 640, 000	7, 334, 000	1, 972, 000	451, 000	2, 423, 000	9, 757, 000
1887–'88	3, 841, 000	3, 796, 000	7, 637, 000	2, 030, 000	500, 000	2, 530, 000	10, 167, 000
1888–'89	3, 770, 000	4, 069, 000	7, 839, 000	2, 130, 000	555, 000	2, 685, 000	10, 524, 000
1889–'90	4, 034, 000	4, 290, 000	8, 324, 000	2, 102, 000	629, 000	2, 731, 000	11, 055, 000
1890–'91	4, 230, 000	4, 538, 000	8, 768, 000	2, 262, 000	696, 000	2, 958, 000	11, 726, 000
1891–'92 *	4, 020, 000	4, 576, 000	8, 596, 000	2, 430, 000	790, 000	3, 220, 000	11, 816, 000
1892–'93 *	3, 706, 000	4, 576, 000	8, 282, 000	2, 340, 000	849, 000	3, 189, 000	11, 471, 000

* Figures for European consumption for 1891–'92 and 1892–'93 are given as being subject to slight correction.

The consumption of cotton in India for each year since 1877–'78, as stated in the two publications already named in connection with Tables IV and V, is given below, the figures for the last two years being from the Commercial and Financial Chronicle, while those for the other years are alike in both publications:

TABLE VI.—*Consumption of cotton in India.*

Year.	Quantity, bales of 400 pounds.	Year.	Quantity, bales of 400 pounds.	Year.	Quantity, bales of 400 pounds.
1878–'79	262, 230	1883–'84	520, 700	1888–'89	870, 880
1879–'80	301, 480	1884–'85	584, 800	1889–'90	938, 293
1880–'81	371, 400	1885–'86	630, 300	1890–'91	1, 155, 323
1881–'82	389, 600	1886–'87	711, 800	1891–'92	1, 142, 610
1882–'83	447, 400	1887–'88	771, 670	1892–'93	*1, 170, 000

* Estimated.

THE WORLD'S WOOL SUPPLY.

STATISTICS OF PRODUCTION, TRADE AND PRICES.

The first of the tables which follow relates to the production of wool throughout the world. As far as official figures as to the wool product of different countries could be obtained they have been used, but in a majority of cases it has been necessary to use unofficial estimates, or to make as close an estimate as practicable from the number of sheep and probable yield of wool per capita, or from the official record of exports. In some of the great wool-producing countries the domestic consump-

tion is so insignificant, in comparison with the total product, that the latter is approximately indicated by the exportation.

The grouping of countries is that adopted by Dr. F. X. von Neumann-Spallart and Dr. Franz von Juraschek in the estimates of the world's wool product given in their valuable statistical compilation, the Uebersichten der Weltwirtschaft, and in a number of cases the unofficial estimates used are the latest ones found in that publication. But in a majority of cases the figures here given are for a later date than those of Dr. von Juraschek, which are the latest in the Uebersichten. The sources or bases of the different estimates are, however, specifically indicated in foot notes, as are also the authorities for the more precise statements; and a considerable amount of incidental information is given in the same connection.

TABLE 1.—*Approximate statement of the world's wool product according to the latest attainable data.*

Countries.	Year.	Quantity produced.	
		Millions of kilograms.	Pounds.
In Europe:			
Russia	1883	*a* 118·62	261, 509, 652
Great Britain and Ireland	1891	....	*b* 147, 474, 238
France	1892	....	*c* 107, 222, 264
Spain	1880	*30·00	66, 138, 000
German Empire	1892	....	*d* 55, 000, 000
Hungary	1884	*19·57	43, 144, 022
Italy	1891	....	*e* 21, 214, 537
Austria	1891	....	*f* 9, 044, 488
Portugal	1882	*g* 5·21	11, 485, 966
Belgium	1890	*·50	1, 102, 300
Sweden	1890	*1·80	3, 968, 280
Other European countries	......	*35·24	77, 690, 104
Total for Europe	......	....	805, 093, 851
Outside of Europe:			
Australia	1890	....	*h* 505, 712, 887
United States	1892	....	*i* 293, 000, 000
Argentine Republic	1892	....	*j* 340, 908, 398
Uruguay	1892	....	*k* 61, 666, 690
Cape Colony	1892	....	*l* 70, 335, 193
British India	1892	....	*m* 24, 717, 907
Natal	1892	....	*n* 20, 887, 883
Asiatic Turkey	1892	*o* 7·94	17, 504, 524
British North America	1892	....	*p* 10, 000, 000
Other extra-European countries	1891	*q* 40·00	88, 184, 000
Total extra-European countries	......	....	1, 432, 917, 496
SUMMARY.			
Total for Europe	......	....	805, 093, 851
Total extra-European countries	......	....	1, 432, 917, 496
Grand total	......	....	2, 238, 011, 347

NOTES ON TABLE 1.

* Estimates of Dr. Franz von Juraschek in Uebersichten der Weltwirtschaft.

(*a*) These are the figures given by Dr. Franz von Juraschek on p. 468 of Uebersichten der Weltwirtschaft for 1885–1889. His estimate is based on an assumed average yield of 6 Russian pounds of wool per head of sheep, the number of these animals in 1888 having been 48,220,119, without including those in Asiatic Russia.

(*b*) Estimate of the Bradford Observer reproduced in the Wool Book for 1892, p. 64.

(*c*) According to the Bulletin of the Ministry of Agriculture for November, 1893 (twelfth year No. 6), the quantity of wool produced was 486,357 quintals, of which the figures in the table are the equivalent. The number of animals shorn is stated in the same place at 16,591,647, on which the average yield of wool is 2·93 kilograms, or 6·46 pounds per capita. It is probable, however, that the total wool clip, as stated in the table, includes a considerable quantity of pulled and butchers' wool, in which case the average weight per fleece will be less.

(*d*) The number of sheep on December 1, 1892, according to the official figures was 13,589,612, on which number the round number estimate of 55,000,000 pounds is a small fraction more than 4 pounds per capita. The estimate of Dr. von Juraschek for 1883 was 25,590,000 kilograms or 56,415,714 pounds, which was less than 3 pounds per capita on the sheep then in the Empire; whereas Mulhall, estimating for 1887, put the total product of the Empire at 105,000,000 pounds. The number of sheep has diminished by more than 5,600,000 within the last ten years.

(*e*) The official figures for 1891, as found on page 389 of the Annuario Statistico Italiano for 1892,

UNITED STATES.

In Table 2 the wool product of the United States is presented by States and Territories, as shown in the several censuses from the Seventh to the Eleventh, inclusive. The figures therein given are, however, far from including the total quantity of wool produced. This will be seen by footnotes *a* and *b* in the case of the censuses of 1880 and

make the quantity of wool produced in that year 9,622,851 kilograms, or, as stated in the table, 21,214,537 pounds, and the value 18,306,975 lire, or $3,533,246.

(*f*) According to the animal census of December 31, 1890, there were in Austria at that time 3,186,787 sheep, against 3,841,340 in 1880. The yield of wool in 1881 was officially reported in part 2 of the Statistisches Jahrbuch des K. K. Ackerbau-Ministeriums for 1881 at 49,452 metric centners (or quintals), and, assuming the yield in 1891 to have been proportionally the same, the quantity of wool obtained from the reduced number of sheep would be 41,025·53 metric centners, or, as estimated in the table, 9,044,483 pounds. This seems a low estimate, being at the average rate of less than 1·29 kilograms, or about 2·8 pounds, of wool per head of sheep.

(*g*) This is on the basis of 2,977,454 sheep, the number in the Kingdom in 1882, and of 1¾ kilograms of wool per capita. The number of sheep is found in the Statesman's Year Book for 1889, and the yield of wool per capita is that assumed by Dr. F. X. von Neumann-Spallart and his successor, Dr. von Juraschek, in Uebersichten der Weltwirtschaft for 1885–1889. The estimate appears to be rather high, but is retained for want of a definite basis for a different one.

(*h*) The net export of the Australasian colonies for 1890 was 493,105,556 pounds, or 12,607,331 pounds less than the total product as stated in the table. The figures there given are from p. 304 of the Victorian Year Book for 1892, a work prepared by Henry Heylin Hayter, government statist of the colony of Victoria. The net export was 520,481,863 pounds in 1889, and 642,637,738 in 1891; and if we suppose the net export in these years to have fallen short of the total production by about the same amount as in 1890, we shall have as the total production about 533,000,000 pounds in 1889 and 655,000,000 pounds in 1891. The woolen mills of Victoria and New Zealand, according to the latest official handbooks for these colonies, used in 1891 and 1892 the quantities named below:

Country.	1891.	1892.
	Pounds.	*Pounds.*
Victoria	1,780,859	2,474,441
New Zealand	2,918,073	3,388,954
The two colonies	4,698,932	5,863,395

The figures for New Zealand are given as representing the quantities purchased. No statistics are at hand as to the quantities consumed in the other Australasian colonies.

(*i*) Official figures.

(*j*) This is the quantity of wool exported. The exports for 1891 amounted to 305,570,430 pounds. The quantity manufactured in the republic must be insignificant, and the figures on production, were any available, could not greatly exceed the figures on exportation. The figures on exportation here given are from the official report on commerce and navigation for 1892, kilograms, however, being reduced to their equivalent in pounds.

(*k*) This is the quantity exported as wool of domestic origin during the year. No imports of unmanufactured wool are recorded for 1892 in the "Annuario Estadistico de la Republica Oriental del Uruguay," from which document the quantity exported (stated in kilograms) is obtained. The number of sheep in Uruguay in 1892 is officially stated at 11,012,769, on which number the exports for the year would be an average of about 5·7 pounds per capita. Some estimates, however, place the number of sheep considerably higher than that expressed by the official figures, on the ground that thousands of stock-raisers fail to make returns of the animals owned by them.

(*l*) Net exports as stated in the Statistical Abstract of the Colonial and other possessions of the United Kingdom, p. 41, thirtieth number. The net export for 1890 is stated in the same place at 65,655,917 pounds and that for 1891 at 75,520,791 pounds.

(*m*) This is the net export during the Indian fiscal year extending from April 1, 1892, to March 31, 1893, inclusive. It is, of course, much less than the total product, but the latter is difficult to estimate with any approach to exactness. The number of sheep and goats in British India, exclusive of Bengal and the Central provinces, in 1891–'92, is stated in No. 27 of the Statistical Abstract for British India (p. 157) at 28,975,156, to which Bengal and the Central provinces would probably add a few millions more. The numbers of sheep and goats, respectively, are, however, not separately stated. Dr. von Juraschek, in his Uebersichten der Weltwirthschaft, while giving in his table the quantity exported, gives in a footnote an estimate of the total wool product, based on the number of sheep and goats together, placing it at from 30,000,000 to 40,000,000 kilograms. The lower of these estimates, which is probably above, rather than below, the mark, is equivalent to 66,138,000 pounds.

(*n*) This is the net export of sheep's wool, as stated in the Statistical Abstract of the Colonial and other possessions of the United Kingdom, thirtieth number. The number of sheep in the colony in 1891 is stated in the same document at 959,246, on which the net export of wool in 1892 would amount to an average of over 21¾ pounds per capita. It is evident from this that the wool shipped from the ports of Natal must have included a large quantity produced on adjoining territory.

(*o*) The exports from Turkey, including Turkey in Europe, to the United Kingdom alone amounted in 1890 to 17,458,657 pounds of sheep or lambs' wool, and 4,120,222 pounds of goat's wool or hair; in 1891 it amounted to 17,805,113 of the former and 6,496,115 of the latter; in 1892 it amounted to 22,774,764 of the former and 7,774,541 of the latter.

(*p*) The number of sheep in Canada in 1891 is stated in the Statistical Yearbook of Canada for 1892 at 2,513,977, on which the round-number estimate of 10,000,000 pounds of wool is a fraction less than 4 pounds per capita. The exports of home-grown wool from the Dominion during the fiscal year ending June 30, 1892, amounted to 916,390 pounds.

(*q*) This is an estimate of the English firm of Jacoms, Son & Co. It includes the wools of Peru, Chili, Brazil, Egypt, Tunis, Algiers, and other countries.

1890, and the figures for the preceding censuses are, no doubt, similarly incomplete from like causes.

TABLE 2.—*Wool product by States and Territories, as shown by each census from the Seventh to the Eleventh, inclusive.*

States and Territories.	1850.	1860.	1870.	1880. *a*	1890. *b*
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Alabama	657,118	775,117	381,253	762,207	768,589
Arizona	....	....	679	313,698	551,565
Arkansas	182,595	410,382	214,784	557,368	512,396
California	5,520	2,683,109	11,391,743	16,798,036	16,358,547
Colorado	....	....	204,925	3,197,391	3,334,234
Connecticut	497,454	335,896	254,129	230,133	126,508
Dakota: North	....	....	8,810	157,025	510,417
South	....	....			1,073,909
Delaware	57,768	50,201	58,316	97,946	47,281
District of Columbia	525	100	....	....	....
Florida	23,247	59,171	37,562	162,810	221,954
Georgia	990,019	946,227	846,947	1,289,560	841,141
Idaho	....	....	3,415	127,149	2,119,242
Illinois	2,150,113	1,989,567	5,739,249	6,093,066	4,490,773
Indiana	2,610,287	2,552,318	5,029,023	6,167,498	4,863,404
Iowa	373,898	660,858	2,967,043	2,971,975	2,649,652
Kansas	....	24,746	335,005	2,855,832	2,253,240
Kentucky	2,297,433	2,329,105	2,234,450	4,592,576	2,777,533
Louisiana	109,897	290,847	140,428	406,678	440,686
Maine	1,364,034	1,495,060	1,774,168	2,776,407	1,864,009
Maryland	477,438	491,511	435,213	850,084	543,225
Massachusetts	585,136	377,267	306,659	299,089	241,314
Michigan	2,043,283	3,960,888	8,726,145	11,858,497	12,378,318
Minnesota	85	20,388	401,185	1,352,124	1,945,249
Mississippi	559,619	665,959	288,285	734,643	1,038,186
Missouri	1,627,164	2,069,778	3,649,390	7,313,924	4,040,084
Montana	....	....	100	995,484	9,335,551
Nebraska	....	3,302	74,655	1,282,656	791,534
Nevada	....	330	27,029	655,012	1,450,868
New Hampshire	1,108,476	1,160,222	1,129,442	1,060,589	717,149
New Jersey	375,396	349,250	336,609	441,110	180,844
New Mexico	32,901	492,645	684,930	4,019,188	4,074,503
New York	10,071,301	9,454,474	10,599,225	8,827,195	6,715,686
North Carolina	970,738	883,473	799,667	917,756	733,765
Ohio	10,196,371	10,608,927	20,539,643	25,003,756	20,987,574
Oklahoma	....	....	....	....	59,114
Oregon	29,686	219,012	1,080,638	5,718,524	9,982,910
Pennsylvania	4,481,570	4,752,522	6,561,722	8,470,273	6,441,164
Rhode Island	129,692	90,699	77,328	65,680	41,021
South Carolina	487,233	427,102	156,314	272,758	157,707
Tennessee	1,364,378	1,405,236	1,389,762	1,918,295	1,397,666
Texas	131,917	1,493,738	1,251,328	6,928,019	14,917,068
Utah	9,222	74,765	109,018	973,246	4,660,250
Vermont	3,400,717	3,118,950	3,102,137	2,551,113	2,118,883
Virginia	2,860,765	2,510,019	877,110	1,836,673	1,449,219
Washington	....	19,819	162,713	1,339,122	1,556,792
West Virginia	....	....	1,593,541	2,681,444	2,560,859
Wisconsin	253,963	1,011,933	4,090,670	7,016,491	4,981,083
Wyoming	....	....	30,000	691,650	4,146,773
The United States	52,516,959	60,264,913	*c* 100,102,387	155,681,751	165,449,239

NOTES ON TABLE 2.

(*a*) Not including the following items, the result of special investigation: Texas and California, fall clip of sheep reported on farms, 13,000,000 pounds; wool of other (ranch) sheep, 34,000,000 pounds; pulled wool and fleece, of slaughtered sheep, 38,000,000 pounds; making an aggregate of 240,681,751 pounds.

(*b*) Including wool shorn in the fall of 1889 and the spring of 1890, but not pulled wool or wool on ranges, which last is reported as follows:

	Pounds.		Pounds.
Arizona	1,630,172	South Dakota	380
California	7,734,407	Texas	3,480,114
Colorado	1,210,098	Utah	5,025,263
Montana	2,841,916		
New Mexico	3,906,495	Total	25,828,845

If the item of wool on ranges be added to the 165,449,239 pounds given above we shall have as a grand total 191,278,084 pounds. The difference between these figures and those of the Department of Agriculture for the same year is in large part covered by pulled wool and the fleece of slaughtered sheep.

(*c*) The difference between these figures and those of the Department of Agriculture for 1870 is obviously explicable in much the same manner as the differences for 1880 and 1890 noticed in notes *a* and *b*, though no detailed estimates are at hand as to the quantities of wool covered by the items which are omitted from the census figures. Exact agreement is, of course, not to be expected where the results are arrived at by different methods.

The number, average price, and value of sheep in the United States for each year from 1871 to 1892, inclusive, will be found on page 462 of the Report of the Secretary of Agriculture for 1892. The figures for January, 1893 and 1894, are given below:

	Number.	Average price.	Value.
January, 1893	47, 273, 553	$2. 66	$125, 909, 264
January, 1894	45, 048, 017	1. 98	89, 186, 110

This shows a considerable reduction in number and a still greater one in value; but the number is slightly larger than in January, 1892, and larger by 1,616,881 than in January, 1891. The average price was lower by 8 cents per head in 1886 and only 2 cents per head higher in 1887 than in January last. Statistics for the States and Territories in detail will be found in another article contained in a preceding part of this report.

The next table shows our total supply of wool for home consumption, from both domestic and foreign sources, for the census years 1840, 1850, and 1860, and for each year from 1863 to 1893, inclusive. The figures on our own production from 1863 are those which have been furnished by the Statistician of the Department of Agriculture for use in the Statistical Abstract of the United States, published from year to year by the Bureau of Statistics of the Treasury Department, while the figures on imports and exports are those of that Bureau itself.

TABLE 3.—*Quantities of wool produced, imported, exported, and retained for consumption in the United States from 1840 to 1892, inclusive.*

Year ending June 30—	Production.	Exports of domestic.	Domestic retained for consumption.	Imports.	Exports of foreign.	Foreign retained for consumption.	Total consumption, domestic and foreign.	Per cent of consumption foreign.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
1840 *	35, 802, 114	....	35, 802, 114	9, 898, 740	85, 528	9, 813, 212	45, 615, 326	21·5
1850	52, 516, 959	35, 898	52, 481, 061	18, 695, 294	....	18, 695, 294	71, 176, 355	26·3
1860	60, 264, 913	1, 055, 928	59, 208, 935	26, 282, 955	157, 064	26, 125, 891	85, 334, 876	30·6
1863	106, 000, 000	355, 722	105, 644, 278	75, 121, 728	708, 850	74, 412, 878	180, 057, 156	41·3
1864	123, 000, 000	155, 482	122, 844, 518	91, 250, 114	223, 475	91, 026, 639	213, 871, 157	42·6
1865	142, 000, 000	466, 182	141, 533, 818	44, 420, 375	679, 281	43, 741, 094	185, 274, 912	23·6
1866	155, 000, 000	973, 075	154, 026, 925	71, 287, 988	852, 045	70, 435, 943	224, 462, 868	31·0
1867	160, 000, 000	307, 418	159, 692, 582	38, 158, 382	619, 614	37, 538, 768	197, 231, 350	19·0
1868	168, 000, 000	558, 435	167, 441, 565	25, 467, 336	2, 801, 852	22, 665, 484	190, 107, 049	11·9
1869	180, 000, 000	444, 387	179, 555, 613	39, 275, 926	342, 417	38, 933, 509	218, 489, 122	17·8
1870	162, 000, 000	152, 892	161, 847, 108	49, 230, 199	1, 710, 053	47, 520, 146	209, 367, 254	22·7
1871	†160, 000, 000	25, 195	159, 974, 805	68, 058, 028	1, 305, 311	66, 752, 717	226, 727, 522	29·4
1872	150, 000, 000	140, 515	149, 859, 485	126, 507, 409	2, 343, 937	124, 163, 472	274, 022, 957	45·3
1873	158, 000, 000	75, 129	157, 924, 871	85, 496, 049	7, 040, 386	78, 455, 663	236, 380, 534	33·2
1874	170, 000, 000	319, 600	169, 680, 400	42, 939, 541	6, 816, 157	36, 123, 384	205, 803, 784	17·5
1875	181, 000, 000	178, 034	180, 821, 966	54, 901, 760	3, 567, 627	51, 334, 133	232, 156, 099	22·1
1876	192, 000, 000	104, 768	191, 895, 232	44, 642, 836	1, 518, 426	43, 124, 420	235, 019, 642	18·3
1877	200, 000, 000	79, 599	199, 920, 401	42, 171, 192	3, 088, 957	39, 082, 235	239, 002, 636	16·3
1878	208, 250, 000	347, 854	207, 902, 146	48, 449, 079	5, 952, 221	42, 496, 858	250, 399, 004	16·9
1879	211, 000, 000	60, 784	210, 939, 216	39, 005, 155	4, 104, 616	34, 900, 539	245, 839, 755	14·2
1880	232, 500, 000	191, 551	232, 308, 449	128, 131, 747	3, 648, 520	124, 483, 227	356, 791, 676	34·9
1881	240, 000, 000	71, 455	239, 928, 545	55, 964, 236	5, 507, 534	50, 456, 702	290, 385, 247	17·3
1882	272, 000, 000	116, 179	271, 883, 821	67, 861, 744	3, 831, 836	64, 029, 908	335, 913, 729	19·0
1883	290, 000, 000	64, 474	289, 935, 526	70, 575, 478	4, 010, 043	66, 565, 435	356, 500, 961	18·7
1884	300, 000, 000	10, 393	299, 989, 607	78, 350, 651	2, 304, 701	76, 045, 950	376, 035, 557	20·6
1885	308, 000, 000	88, 006	307, 911, 994	70, 596, 170	3, 115, 339	67, 480, 831	375, 392, 825	18·0
1886	302, 000, 000	146, 423	301, 853, 577	129, 084, 958	6, 534, 426	122, 550, 532	424, 404, 109	28·9
1887	285, 000, 000	257, 940	284, 742, 060	114, 038, 030	6, 728, 292	107, 309, 738	392, 051, 798	27·4
1888	269, 000, 000	22, 164	268, 977, 836	113, 558, 753	4, 359, 731	109, 199, 022	378, 176, 858	28·9
1889	265, 000, 000	141, 576	264, 858, 424	126, 487, 729	3, 263, 094	123, 224, 635	388, 083, 059	31·8
1890	276, 000, 000	231, 042	275, 768, 958	105, 431, 285	3, 288, 467	102, 142, 818	377, 911, 776	27·0
1891	285, 000, 000	291, 922	284, 708, 078	129, 303, 648	2, 638, 123	126, 665, 525	411, 373, 603	30·8
1892	†294, 000, 000	202, 456	293, 797, 544	148, 670, 652	3, 007, 563	145, 663, 089	439, 460, 633	33·1
1893	303, 151, 055	91, 858	303, 059, 197	172, 433, 838	4, 218, 637	168, 215, 201	471, 274, 398	35·7

* Year ending September 30.

† In the Report of the Statistician for 1892 the quantity of wool grown in 1871 is stated at 153,000,000 and that of wool grown in 1892 at 293,000,000 pounds. (*See* p. 462 of the Report of the Secretary of Agriculture for 1892.)

If we compare the average wool product of the last five years with that of the first five years of the thirty-year period, 1864–1893, we find the increase in production to be a fraction over 90 per cent. A comparison of our total consumption for the same two quinquennial periods shows that it was somewhat more than twice as great during the last as it was during the first five years of the thirty-year period in question.

In Bulletin 169, issued by the Superintendent of the Eleventh Census, the quantity of domestic wool consumed in the woolen industry of the United States in the census year is stated at 258,757,101 pounds, and the quantity of foreign wool at 114,116,612 pounds. On this basis the domestic wool would form 69·4 and the foreign 30·6 of our total consumption. But these figures, as is pointed out in the bulletin referred to, do not cover the whole ground, and a careful examination of the figures to be added, as estimated in the same bulletin, indicates that a complete statement would somewhat increase the proportioh ef foreign wool used. It would probably be very near the truth if the domestic wool should be estimated at two thirds and the foreign wool at one-third of the total quantity used in our woolen manufactures during the year covered by the census figures.

The latter are presented as subject to correction in a final report to be issued from the Census Office; but, taken as they stand, they lead us to substantially the same result which is indicated by the figures on our total consumption for the fiscal year ending June 30, 1890,* as presented above in Table 3, although the latter were, of course, obtained from different sources and by different methods.

UNITED KINGDOM.

Table 4, below, shows for the twenty years, 1873–1892, divided into four periods of five years each, the quantities of wool of sheep, lambs, alpacas, and the llama tribe imported into the United Kingdom from various sources, with the quantities reëxported, the estimated domestic product, the exports of wool of domestic origin, and the quantities remaining for home consumption:

TABLE 4.—*Imports, exports, production, and consumption of wool for the four quinquennial periods, 1873–1877, 1878–1882, 1883–1887, and 1888–1892, and also the number of sheep in the kingdom through each period.*

PERIOD I.

Sources of supply.	1873.	1874.	1875.	1876.	1877.	Average per annum.	Per cent of total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Russia	11, 168, 563	11, 930, 451	15, 084, 644	12, 948, 451	12, 920, 038	12, 810, 429	3·5
Germany	8, 294, 628	7, 163, 695	7, 320, 760	8, 371, 549	9, 517, 450	8, 133, 616	2·2
France	1, 557, 165	2, 291, 470	1, 548, 206	1, 675, 527	2, 355, 810	1, 885, 636	·5
Holland and Belgium	2, 240, 858	5, 036, 272	3, 915, 254	6, 060, 206	4, 305, 246	4, 311, 567	1·2
Turkey, European and Asiatic	8, 234, 491	4, 802, 486	5, 561, 094	6, 959, 146	7, 213, 624	6, 554, 768	1·8
Egypt	4, 588, 323	1, 900, 072	2, 247, 769	3, 569, 808	4, 438, 143	3, 348, 823	·9
British Possessions in South Africa	42, 057, 187	42, 232, 672	44, 112, 213	42, 158, 317	41, 607, 778	42, 433, 633	11·6
British Possessions in the East Indies	19, 362, 908	19, 127, 534	22, 819, 289	24, 453, 817	21, 566, 074	21, 465, 924	5·9
Australasia	186, 664, 946	225, 383, 631	238, 631, 716	263, 869, 157	281, 247, 190	239, 159, 328	65·4

* This being substantially the same as the year covered by the census figures.

TABLE 4.—*Imports, exports, production, and consumption of wool for the four quinquennial periods, 1873–1877, 1878–1882, 1883–1887, and 1888–1892, etc.*—Continued.

Sources of supply.	1873.	1874.	1875.	1876.	1877.	Average per annum.	Per cent of total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
South America	21, 099, 262	14, 878, 918	11, 954, 327	11, 543, 559	15, 352, 301	14, 965, 673	4·1
All other countries	12, 768, 448	9, 723, 696	11, 867, 306	8, 446, 222	9, 425, 544	10, 446, 243	2·9
Total	318, 036, 779	344, 470, 897	365, 065, 578	390, 055, 759	409, 949, 198	365, 515, 642	100
Reexported	123, 246, 172	144, 294, 663	172, 075, 439	173, 020, 372	187, 418, 627	160, 011, 054	43·8
Net imports	194, 790, 607	200, 176, 234	192, 990, 139	217, 035, 387	222, 530, 571	205, 504, 588	56·2
Domestic product*	165, 350, 472	167, 042, 379	161, 782, 536	155, 835, 320	152, 172, 010	160, 436, 543	....
Net imports plus domestic product	360, 141, 079	367, 213, 613	354, 772, 675	372, 870, 707	374, 702, 581	365, 941, 131	....
Exports of home-grown wool	7, 034, 735	10, 077, 619	10, 536, 523	9, 817, 249	9, 548, 999	9, 403, 025	....
Quantity left for home consumption	353, 106, 344	357, 140, 994	344, 236, 152	363, 053, 458	365, 153, 582	356, 538, 106	....
Number of sheep in the United Kingdom	33, 982, 404	34, 837, 597	33, 491, 948	32, 262, 579	32, 220, 067	33, 358, 919	....

* Estimates of the Bradford Observer as reproduced in the Wool Book for 1892.

PERIOD II.

Sources of supply.	1878.	1879.	1880.	1881.	1882.	Average per annum.	Per cent of total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Russia	8, 626, 750	15, 924, 829	20, 082, 340	15, 794, 697	17, 537, 760	15, 593, 275	3·5
Germany	4, 560, 485	4, 323, 054	7, 173, 932	2, 263, 651	2, 727, 703	4, 209, 765	·9
France	2, 054, 159	5, 586, 605	9, 057, 016	3, 011, 134	4, 830, 383	4, 907, 859	1·1
Holland and Belgium	4, 970, 063	6, 345, 501	7, 838, 971	5, 133, 227	5, 919, 727	6, 041, 498	1·4
Turkey, European and Asiatic	11, 245, 867	6, 436, 514	12, 431, 611	6, 718, 782	9, 399, 575	9, 246, 470	2·1
Egypt	2, 589, 859	2, 725, 596	2, 817, 342	1, 986, 796	1, 486, 819	2, 321, 282	·5
British Possessions in South Africa	40, 955, 948	45, 926, 294	51, 385, 839	49, 530, 875	53, 876, 065	48, 335, 004	10·9
British Possessions in the East Indies	27, 039, 725	22, 202, 554	29, 190, 049	22, 215, 223	26, 923, 704	25, 514, 251	5·8
Australasia	276, 172, 193	287, 831, 804	300, 626, 654	329, 665, 855	345, 783, 786	308, 016, 058	69·4
South America	11, 259, 754	12, 867, 657	10, 282, 206	5, 873, 192	10, 872, 521	10, 231, 066	2·3
All other countries	9, 974, 632	6, 939, 691	12, 623, 003	7, 948, 303	9, 627, 014	9, 422, 529	2·1
Total	399, 449, 435	417, 110, 099	463, 508, 963	450, 141, 735	488, 985, 057	443, 839, 058	100
Reexported	199, 286, 544	243, 386, 008	237, 408, 589	265, 583, 927	263, 965, 744	241, 926, 163	54·5
Net imports	200, 162, 891	173, 724, 091	226, 100, 374	184, 557, 808	225, 019, 313	201, 912, 895	45·5
Domestic product	151, 700, 736	153, 233, 696	148, 729, 061	138, 574, 672	129, 006, 659	144, 248, 965	....
Net imports, plus domestic product	351, 863, 627	326, 957, 787	374, 829, 435	323, 132, 480	354, 025, 972	346, 161, 860	....
Exports of home-grown wool	6, 618, 200	15, 703, 900	17, 197, 300	14, 068, 900	13, 846, 400	13, 486, 940	....
Quantity left for home consumption	345, 245, 427	311, 253, 887	357, 632, 135	309, 063, 580	340, 179, 572	332, 674, 920	....
Number of sheep in the United Kingdom	32, 571, 018	32, 237, 958	30, 239, 620	27, 896, 273	27, 448, 220	30, 078, 618	....

TABLE 4.—*Imports, exports, production, and consumption of wool for the four quinquennial periods, 1873–1877, 1878–1882, 1883–1887, and 1888–1892, etc.*—Continued.

PERIOD III.

Sources of supply.	1883.	1884.	1885.	1886.	1887.	Average per annum.	Per cent of total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Russia	28,148,121	22,999,967	29,649,386	29,721,582	27,754,188	27,654,649	5·1
Germany	4,335,436	1,690,331	1,886,954	3,287,788	3,766,550	2,993,412	·6
France	5,337,996	5,585,672	7,621,322	11,464,460	10,234,513	8,048,793	1·5
Holland and Belgium	5,716,132	4,664,701	5,268,013	6,196,977	5,778,891	5,524,943	1
Turkey, European and Asiatic	8,689,970	10,377,542	11,112,489	17,965,124	20,130,920	13,655,209	2·5
Egypt	2,698,842	2,087,369	2,375,614	3,838,228	5,174,973	3,235,005	·6
British Possessions in South Africa	48,870,981	51,334,652	47,013,467	61,257,406	65,312,497	54,757,801	10·1
British possessions in the East Indies	24,822,130	24,799,268	25,697,174	34,596,693	33,783,574	28,739,768	5·3
Australasia	351,685,606	381,403,669	356,055,791	401,425,430	383,506,395	374,815,378	69·4
South America	7,064,219	15,362,870	12,868,622	16,976,066	13,288,801	13,112,116	2·4
All other countries	8,577,346	6,220,620	6,138,758	9,741,241	9,193,359	7,974,265	1·5
Total	495,946,779	526,526,661	505,687,590	596,470,995	577,924,661	540,511,337	100
Reexported	277,234,084	276,919,073	267,501,675	312,006,380	319,202,968	290,572,836	53·8
Net imports	218,712,695	249,607,588	238,185,915	284,464,615	258,721,693	249,938,501	46·2
Domestic product	128,338,115	132,410,620	136,130,382	136,544,876	133,809,882	133,446,775	......
Net imports plus domestic product	347,050,810	382,018,208	374,316,297	421,009,491	392,531,575	383,385,276	......
Exports of home-grown wool	19,443,100	18,128,800	23,459,500	22,225,200	19,557,700	20,562,860	......
Quantity left for home consumption	327,607,710	363,889,408	350,856,797	398,784,291	372,973,875	362,822,416	......
Number of sheep in the United Kingdom	28,347,560	29,376,787	30,086,200	28,955,240	29,401,750	29,233,507	......

PERIOD IV.

Sources of supply.	1888.	1889.	1890.	1891.	1892.	Average per annum.	Per cent of total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Russia	24,626,644	44,242,452	24,785,500	38,382,854	24,403,157	31,288,121	4·5
Germany	3,887,736	5,190,082	6,733,552	4,751,067	5,570,720	5,226,631	·8
France	14,098,202	24,531,311	10,873,788	12,270,828	17,060,677	15,766,961	2·3
Holland and Belgium	5,953,845	14,105,482	6,697,466	6,013,549	6,298,436	7,813,756	1·1
Turkey, European and Asiatic	17,700,718	21,312,123	17,458,657	17,817,973	22,774,764	19,412,847	2·8
Egypt	3,601,420	3,456,350	2,298,243	1,515,298	1,570,915	2,488,445	·4
British Possessions in South Africa	83,647,956	90,189,138	87,221,926	96,662,069	82,071,288	87,958,475	12·8
British Possessions in East Indies	34,438,026	35,598,921	34,238,586	36,503,864	37,608,257	35,677,531	5·2
Australasia	427,974,038	431,303,391	418,771,604	477,727,486	513,405,793	453,836,462	66
South America	13,611,178	16,343,005	11,173,692	12,858,985	17,566,967	14,310,765	2·1
All other countries	9,728,212	14,630,802	12,775,117	15,510,097	14,715,130	13,471,872	2
Total	639,267,975	700,903,057	633,028,131	720,014,070	743,046,104	687,251,867	100
Reexported	339,075,483	363,647,360	340,712,303	384,224,656	430,828,993	371,697,759	54·1
Net imports	300,192,492	337,255,697	292,315,828	335,789,414	312,217,111	315,554,108	45·9
Domestic product	133,623,281	132,772,200	137,724,700	147,474,238	153,380,000	140,994,884	......
Net imports plus domestic product	433,815,773	470,027,897	430,040,528	483,263,652	465,597,111	456,548,992	......
Exports of home-grown wool	23,588,200	21,768,400	19,495,100	16,727,800	17,928,100	19,901,520	......
Quantity left for home consumption	410,227,573	448,259,497	410,545,428	466,535,852	447,669,011	436,647,472	......
Number of sheep in the United Kingdom	28,938,716	29,484,774	31,667,195	33,533,983	33,642,808	31,453,496	......

Let us now bring together some of the principal data comprised in the several five-year averages. They are succinctly presented in the following short table:

TABLE 5.—*Averages for the four periods covered by Table 4.*

	Period I (1873-1877).		Period II (1878-1882).		Period III (1883-1887).		Period IV (1888-1892).	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
Total imports	365, 515, 642	100	443, 839, 058	100	540, 511, 337	100	687, 251, 867	100
Imported wool reëxported	160, 011, 054	43·8	241, 926, 163	54·5	290, 572, 836	53·8	371, 697, 759	54·1
Imported wool remaining	205, 504, 588	56·2	201, 912, 895	45·5	249, 938, 501	46·2	315, 554, 108	45·9
Domestic product	160, 436, 543	100	144, 248, 965	100	133, 446, 775	100	140, 994, 884	100
Domestic wool exported	9, 403, 025	5·9	13, 486, 940	9·3	20, 562, 860	15·4	19, 901, 520	14·1
Domestic wool remaining	151, 033, 518	94·1	130, 762, 025	90·7	112, 883, 915	84·6	121, 093, 364	85·9
Imported wool remaining (as above)	205, 504, 588	......	201, 912, 895	......	249, 938, 501	......	315, 554, 108	......
Total supply for consumption	356, 538, 106	......	332, 674, 920	......	362, 822, 416	......	436, 647, 472	......

The foregoing table shows a continuous increase in the total imports from period to period. The percentage of imported wool reëxported increases from 43·8 in Period I to 54·5 in Period II, the percentage remaining for consumption undergoing, of course, a corresponding decrease; but for the last three periods there is little change.

In the domestic product there is a large decrease (averaging over 16,000,000 pounds a year) as between the first period and the second, and one about two-thirds as large between the second and third; but the fourth period shows an increase over the third, averaging more than 7½ million pounds a year. On the other hand, the percentage of domestic wool exported increases from period to period, until we reach the fourth, in which it shows a slight decrease as compared with the third. The changes in the percentage of domestic wool remaining for consumption are, of course, indicated by what has just been said as to the changes in the percentage exported, an increment in the latter meaning a corresponding decrement in the former, and *vice versa.*

The percentages so far noticed appear in Table 5, but no figures are there given to show what percentage of the total consumption consists of imported and what percentage of domestic wool. This is, however, easily ascertained from the figures given in the columns of quantities. The result of a computation upon this point is given below:

TABLE 6.—*Proportions of foreign and domestic wool consumed.*

	Period I.	Period II.	Period III.	Period IV.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Imported wool	57·6	60·7	68·9	72·3
Domestic wool	42·4	39·3	31·1	27·7
Total	100	100	100	100

This table shows a progressive increase in the percentage of imported and a corresponding decrease in the percentage of domestic wool.

The total consumption of wool, as shown in Table 5, was smallest in Period II, but Period III shows an increase over Period I, and Period IV shows a large increase over Period III.

This increase of consumption without any corresponding increase, and, indeed, on the whole with a large decrease, in the domestic supply,* necessitates increasing dependence on the supplies of imported wool; and a comparison of the quantities of such wool remaining for consumption, as exhibited in Table 5, shows that with the exception of a slight decrease in Period II as compared with Period I, the increase has been large and continuous, though there has naturally been considerable fluctuation from year to year in each of the four periods, as will be seen by reference to Table 4.

The following short table presents in compact form a view of the proportions of the total imports of wool, derived from the principal and other sources of supply, as shown in Table 4:

TABLE 7.—*Percentage of imports by sources.*

Sources of supply.	Period I.	Period II.	Period III.	Period IV.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Russia	3·5	3·5	5·1	4·5
British Possessions in South Africa	11·6	10·9	10·1	12·8
British Possessions in East India	5·9	5·8	5·3	5·2
Australasia	65·4	69·4	69·4	66
South America	4·1	2·3	2·4	2·1
Total from principal sources	90·5	91·9	92·3	90·6
Total from all other sources	9·5	8·1	7·7	9·4
Grand total	100	100	100	100

This table shows that while (as we have seen by Table 5) the total imports have been continuously and largely increasing from period to period, the proportions derived from the several sources of supply have varied comparatively little. Perhaps the most striking fact which Table 7 exhibits is the large extent to which the British supply of imported wool is derived from the British Possessions,† particularly Australasia and South Africa, but scarcely less remarkable is the smallness of the percentage contributed by the great wool-producing countries of South America.

The estimated production of domestic wool in 1893 is stated in a recent number of the Mark Lane Express at about 150,612,000 pounds, but the official figures on imports and exports for that year are not yet available. The same paper states the number of sheep in the Kingdom in 1893, as returned by the board of agriculture, at 31,774,824.

EXPORTS FROM THE CHIEF WOOL-PRODUCING COUNTRIES.

The following tables, from 8 to 10, inclusive, give the exports of wool from the principal wool-producing countries of the world outside of Europe and the United States. They cover a period of twenty years ending with 1892, except in the case of Australasia, for which the figures for 1891 are the latest at hand.

*This, notwithstanding the increase in Period IV, as compared with Period III.

†The British dependencies mentioned in Table 7, to say nothing of those included under the designation "other sources," contributed in the first period 82·9, in the second 86·1, in the third 84·8, and in the fourth 84 per cent of the wool imported into the United Kingdom.

TABLE 8.—*Wool of domestic production exported from the chief British Possessions.*

[From the Statistical Abstract for the Colonial and Other Possessions of the United Kingdom.]

Year.	India (year beginning Apr. 1).	Australasia (year beginning Jan. 1).	Natal (year beginning Jan. 1).	Cape of Good Hope (year beginning Jan. 1).	Dominion of Canada (year beginning July 1).	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1873	20, 333, 372	209, 739, 473	6, 309, 573	40, 394, 326	2, 764, 796	279, 541, 540
1874	21, 290, 782	231, 779, 119	7, 888, 994	42, 620, 481	2, 647, 498	306, 226, 874
1875	23, 767, 692	232, 932, 196	8, 109, 447	40, 339, 674	2, 907, 229	308, 056, 238
1876	24, 056, 767	279, 520, 873	8, 550, 177	34, 861, 339	3, 476, 484	349, 465, 640
1877	23, 075, 323	290, 455, 316	10, 012, 356	36, 020, 571	2, 445, 893	362, 009, 459
1878	26, 568, 518	301, 518, 670	12, 077, 966	32, 127, 167	3, 013, 587	375, 305, 908
1879	26, 368, 794	297, 939, 084	12, 029, 216	40, 037, 593	3, 619, 181	380, 043, 868
1880	22, 602, 690	345, 010, 328	15, 283, 049	42, 468, 662	1, 404, 123	426, 768, 852
1881	21, 580, 618	325, 209, 385	12, 578, 781	42, 770, 244	1, 053, 305	403, 192, 333
1882	21, 561, 303	341, 015, 397	14, 056, 126	41, 689, 119	1, 375, 572	419, 697, 517
1883	20, 036, 196	401, 774, 926	15, 826, 915	38, 029, 495	1, 501, 031	477, 168, 563
1884	18, 928, 173	415, 518, 253	17, 330, 981	37, 270, 615	989, 925	490, 037, 952
1885	23, 148, 763	404, 088, 149	17, 906, 044	34, 432, 562	1, 524, 184	481, 099, 702
1886	23, 208, 643	394, 854, 640	21, 750, 863	47, 454, 153	1, 416, 238	488, 684, 537
1887	23, 877, 031	454, 331, 049	22, 250, 834	44, 758, 295	954, 975	546, 172, 184
1888	21, 960, 848	473, 135, 722	28, 982, 247	66, 353, 699	1, 015, 001	591, 447, 517
1889	23, 870, 232	520, 481, 863	29, 489, 716	68, 107, 541	1, 047, 754	642, 997, 106
1890	21, 344, 843	493, 105, 556	26, 780, 282	65, 655, 917	1, 108, 286	607, 994, 884
1891	22, 314, 403	642, 637, 738	27, 688, 314	75, 529, 701	916, 399	769, 077, 546
1892	24, 717, 907	....	20, 887, 888	70, 335, 193	1, 168, 834	....

TABLE 9.—*Exports of wool from the Argentine Republic from 1873 to 1892, inclusive.*

Year.	Belgium.	France.	United States.	Italy.	United Kingdom.	Germany.	Other countries.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1873	22, 233, 583	49, 180, 640	10, 062, 987	4, 674, 140	16, 957, 516	1, 674, 863	79, 814, 583	184, 598, 312
1874	24, 719, 474	35, 100, 994	6, 980, 859	4, 351, 598	10, 799, 443	3, 827, 278	91, 034, 939	176, 823, 585
1875	106, 863, 329	47, 708, 287	7, 310, 044	7, 196, 284	7, 786, 012	6, 779, 396	16, 360, 830	200, 004, 182
1876	104, 888, 777	43, 162, 838	7, 126, 914	6, 948, 670	8, 147, 359	10, 539, 328	16, 598, 994	197, 412, 880
1877	114, 676, 727	58, 389, 995	5, 750, 331	5, 966, 474	6, 468, 213	6, 643, 441	16, 709, 360	214, 604, 541
1878	84, 714, 930	58, 992, 631	7, 299, 636	3, 759, 886	2, 062, 805	6, 592, 684	17, 121, 324	180, 543, 896
1879	100, 813, 349	62, 149, 923	8, 406, 570	4, 300, 531	1, 515, 607	8, 687, 006	17, 198, 099	203, 071, 085
1880	84, 209, 534	78, 813, 742	8, 933, 500	6, 587, 433	2, 652, 614	15, 156, 773	18, 634, 783	214, 988, 379
1881	89, 046, 420	83, 003, 990	7, 016, 516	7, 944, 045	5, 451, 590	24, 348, 731	14, 135, 818	230, 947, 110
1882	94, 861, 998	87, 278, 319	2, 185, 211	6, 106, 411	12, 649, 547	31, 739, 247	10, 091, 729	244, 912, 462
1883	76, 458, 431	124, 703, 686	8, 429, 180	4, 762, 913	8, 280, 231	32, 993, 230	5, 405, 055	261, 032, 726
1884	72, 814, 931	122, 358, 730	4, 745, 803	4, 234, 479	4, 385, 232	38, 414, 377	5, 130, 659	252, 084, 211
1885	75, 710, 148	130, 401, 168	9, 346, 840	3, 693, 604	4, 380, 571	53, 640, 912	5, 882, 547	283, 055, 790
1886	71, 491, 928	136, 638, 059	8, 369, 069	4, 336, 856	11, 732, 174	49, 569, 404	9, 157, 401	291, 294, 891
1887	51, 130, 554	113, 044, 361	8, 819, 796	4, 345, 525	3, 740, 648	50, 018, 183	9, 564, 732	240, 663, 799
1888	68, 440, 883	127, 706, 219	5, 142, 157	3, 221, 785	7, 034, 828	66, 873, 316	12, 022, 177	290, 441, 365
1889	67, 413, 868	135, 018, 906	11, 257, 270	3, 561, 913	10, 573, 405	75, 608, 507	9, 122, 050	312, 555, 919
1890	47, 129, 676	123, 062, 642	14, 333, 926	3, 059, 535	10, 613, 011	54, 522, 743	8, 315, 462	261, 036, 995
1891	75, 600, 891	128, 858, 793	12, 745, 123	4, 676, 730	4, 967, 674	62, 897, 051	15, 824, 168	305, 570, 430
1892	64, 569, 511	125, 348, 100	11, 522, 080	6, 525, 358	8, 427, 692	99, 308, 709	25, 206, 948	340, 908, 398

TABLE 10.—*Exports of wool from Uruguay from 1873 to 1892, inclusive.*

Year.	Belgium.	France.	United States.	Italy.	United Kingdom.	Germany.	Other countries.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1873*	....	....	....	....	....	....	....	35, 329, 883
1874	....	....	....	....	....	....	....	37, 361, 358
1875	....	....	....	....	....	....	....	22, 328, 063
1876	....	....	....	....	....	....	....	....
1877	14, 621, 253	11, 437, 873	4, 947, 385	1, 178, 927	917, 158	222, 916	4, 474, 571	37, 800, 083
1878	16, 972, 228	10, 842, 917	4, 787, 152	1, 037, 780	820, 098	209, 025	2, 616, 865	37, 286, 065
1879	13, 067, 202	14, 996, 873	5, 577, 828	2, 431, 103	1, 914, 369	115, 111	1, 379, 574	39, 482, 060
1880	16, 016, 170	12, 579, 862	7, 845, 420	659, 940	928, 783	990	3, 340, 533	41, 371, 698
1881	13, 801, 964	11, 039, 629	3, 811, 771	1, 294, 138	546, 278	224, 869	4, 957, 235	35, 675, 884
1882	21, 551, 634	10, 016, 496	6, 154, 807	1, 006, 854	2, 875, 771	2, 422, 915	2, 787, 915	46, 816, 392
1883	35, 027, 639	11, 835, 772	7, 297, 001	1, 229, 949	2, 803, 881	4, 918, 191	7, 010, 415	70, 122, 848
1884	21, 500, 434	10, 044, 718	3, 037, 434	457, 981	7, 506, 502	6, 150, 556	10, 384, 297	59, 081, 922
1885	28, 167, 742	8, 170, 558	17, 338, 423	722, 816	680, 551	2, 368, 181	7, 286, 830	64, 735, 101
1886	32, 683, 530	5, 393, 488	10, 482, 913	888, 247	7, 815, 642	3, 750, 507	8, 813, 386	69, 827, 713
1887	27, 320, 334	12, 355, 200	2, 688, 113	....	8, 196, 773	2, 955, 341	4, 262, 887	57, 778, 648
1888	29, 741, 335	23, 375, 954	6, 213, 087	681, 444	3, 205, 887	12, 071, 611	8, 752, 135	84, 041, 453
1889	34, 196, 521	32, 809, 325	2, 946, 124	541, 584	2, 197, 164	11, 378, 304	16, 093, 736	100, 162, 758
1890	12, 002, 676	18, 220, 759	453, 680	458, 316	349, 396	4, 096, 680	12, 786, 352	48, 367, 859
1891	15, 725, 943	22, 012, 647	1, 404, 388	282, 429	280, 136	7, 952, 102	9, 463, 627	57, 121, 272
1892	19, 023, 537	15, 433, 664	4, 756, 482	52, 024	3, 522, 532	6, 789, 681	12, 088, 779	61, 666, 699

* Statistics by countries are not available for the years preceding 1877.

Of the exports from the Argentine Republic to other countries than those specifically mentioned a considerable part is comprised in exports to Uruguay, the average for the twenty years covered by the table amounting to 1,073,580 kilograms (2,366,814 pounds) per annum. This quantity may be considered as included in the exports from Uruguay, since that country has no occasion to import wool for home consumption. In like manner an average of 2,032,670¼ kilograms (4,481,225 pounds) included in the exports from Uruguay to "other countries" consists of exports to Argentina and may be considered to be included in the exports from that country.

PRICES.

In a recent communication to this division, Mr. S. N. D. North, secretary of the National Association of Wool Manufacturers, points out that the wools quoted in the American and English markets differ so greatly in condition that no satisfactory comparison can be made except on a scoured basis. In Table 11 below, the Boston prices of fine Ohio fleece scoured are presented side by side with the London prices of a foreign scoured wool of approximately equal quality—namely, Australian average, scoured. The figures are from a table compiled by Messrs. Mauger and Avery, of Boston and New York:

TABLE 11.—*Comparative prices of wool in the United States and England since 1850.*

Year.	Fine Ohio fleece scoured, Boston prices.	Australian average scoured, London prices.	Year.	Fine Ohio fleece scoured, Boston prices.	Australian average scoured, London prices.	Year.	Fine Ohio fleece scoured, Boston prices.	Australian average secured, London prices.
	Per lb.	*Per lb.*		*Per lb.*	*Per lb.*		*Per lb.*	*Per lb.*
1850	$0.83¼	$0.46	1866	$1.31¼	$0.68	1882	$0.90½	$0.53
1851	.85½	.46	1867	1.13¼	.60	1883	.86	.51
1852	.81¾	.56	1868	.88¾	.52	1884	.80½	.48
1853	1.07	.60	1869	.90½	.44	1885	.71¼	.41
1854	.91¼	.52	1870	.89¾	.46	1886	.74	.41
1855	.85¾	.56	1871	1.06¾	.58	1887	.73¼	.42
1856	1.04¾	.66	1872	1.56¾	.74	1888	.68	.42
1857	1.02	.68	1873	1.19¾	.68	1889	.73½	.48
1858	.82½	.64	1874	1.15¼	.66	1890	.73¼	,44
1859	1.09¼	.66	1875	1.04½	.60	1891	.70¾	.40
1860	1.02½	.68	1876	.87	.54	1892	.63	.34
1861	.82¾	.60	1877	.91	.54	1893	.55	.33
1862*	.93¾	.60	1878	.74¾	.54	1894		
1863	1.51½	.62	1879	.71¾	.52	Jan	.50	.32
1864	1.77	.64	1880	1.02¾	.60	Mar	.45½	.32
1865	1.66	.62	1881	.95½	.53			

*From 1862 to 1878 the prices of fine Ohio fleece are in currency. The gold value of the paper dollar for those years was as follows: 1862, 88.3 cents; 1863, 68.9 cents; 1864, 49.2 cents; 1865, 63.6 cents; 1866, 71 cents; 1867, 72.4 cents; 1868, 71.6 cents; 1869, 75.2 cents; 1870, 87 cents; 1871, 89.5 cents; 1872, 89 cents; 1873, 87.9 cents; 1874, 89.9 cents; 1875, 87 cents; 1876, 89.8 cents; 1877, 95.4 cents; 1878, 99.2 cents.

The following figures, which are taken from Senate Report No. 1394, second session, Fifty-second Congress, were obtained for that report through Mr. S. N. D. North, of Boston, Mass., secretary of the National Association of Wool Manufacturers, from Messrs. Mauger and Avery of the same city:

TABLE 12.—*Wholesale prices of wool in the United States.*

Years.	Ohio fine fleece, scoured.		Ohio medium fleece, scoured.	
	Actual prices. (a)	Relative prices, 1860=100. (b)	Actual prices. (a)	Relative prices, 1860=100. (b)
	Per lb.		*Per lb.*	
1850	$0.83¼	$0.812	$0.57½	.810
1851	.85½	.834	.62	.873
1852	.81¾	.798	.56¾	.799
1853	1.07	1.044	.80¼	1.130
1854	.91¼	.890	.65	.915
1855	.85¾	.837	.56½	.796
1856	1.04¾	1.022	.68¼	.961
1857	1.02	.995	.72¾	1.025
1858	.82½	.805	.56¼	.792
1859	1.09¼	1.066	.71¼	1.004
1860	1.02½	1.000	.71	1.000
1861	.82¾	.807	.58	.817
1862	.93¾	.917	.76½	1.077
1863	1.51½	1.478	1.18½	1.669
1864	1.77	1.727	1.39	1.958
1865	1.66	1.620	1.28¼	1.806
1866	1.31¼	1.280	.98½	1.387
1867	1.13¼	1.105	.79¾	1.123
1868	.88¾	.866	.70¾	.996
1869	.90½	.883	.74¼	1.046
1870	.89¾	.876	.69½	.979
1871	1.06¾	1.041	.82	1.155
1872	1.56¾	1.529	1.10¼	1.553
1873	1.19¾	1.168	.85½	1.204
1874	$1.15¼	$1.124	$0.83½	1.176
1875	1.04½	1.020	.79¾	1.123
1876	.87	.849	.67¾	.954
1877	.91	.888	.66¾	.940
1878	.74¾	.729	.63	.887
1879	.71¾	.700	.57¾	.813
1880	1.02¾	1.002	.83¾	1.180
1881	.95½	.932	.72¾	1.025
1882	.90½	.883	.72	1.014
1883	.86	.839	.67¾	.950
1884	.80½	.785	.59	.831
1885	.71¼	.695	.53	.746
1886	.74	.722	.57	.803
1887	.73¼	.715	.61	.859
1888	.68	.663	.54¾	.771
1889	.73½	.717	.61	.859
1890	.73¼	.715	.59¼	.835
1891	.70¾	.690	.58	.817
1892	.63	.615	.55	.775
1893	.55	.537	.45	.634
1894				
Jan	.50	.488	.39	.549
Mar	.45½	.444	.37	.521

(a) From p. 171, Part II. (b) From p. 38, Part I.

TABLE 13.—*Wholesale prices of wool in England since 1845.**

[From p. 200, Part I, Senate Report 1394, second session, Fifty-second Congress.]

Date.	Wool, sheep's: English Southdown.				Wool, sheep's: Port Philip, lambs and fleece.				Wool, sheep's: South Australian lambs.			
	Per 240 pounds.		Per pound.		Per pound.		Per pound.		Per pound.		Per pound.	
					d.	*d.*			*d.*	*d.*		
1845—1850		£13		$0.264	12 to	22	$0.243 to	$0.446	.....		.....	
1851—January		14		.284		18		.365	16 to	19	$0.324 to	$0.385
July		14½		.294	.....		.....		13	19	.264	.385
1852—January		13¾		.279	.....		.....		11	18	.223	.365
July		15		.304	.....		.....		15	24	.304	.487
1853—January		17¼		.350	.....		.....		14	20	.284	.406
July		19½		.395		17		.345	.....		.....	
1854—January	£15½ to	16	$0.314 to	.324	.....		.....		12	19	.243	.385
July	12	12½	.243	.253	.....		.....		12	19	.243	.385
1855—January	12	13½	.243	.274	.....		.....		13	25	.264	.507
July	14	15	.284	.304	.....		.....		13	25	.264	.507
1856—January	14½	15	.294	.304	.....		.....		15	30	.304	.608
July	17½	18	.355	.365	.....		.....		15½	26	.314	.527
1857—February		20		.406	.....		.....		12	24	.243	.487
July		19		.385	18	26	.365	.527	.....		.....	
1858—January		13		.264	16	21	.324	.426	.....		.....	
1859—January		19		.385	18	25	.365	.507	.....		.....	
1860—January		19		.385	22	25	.446	.507	.....		.....	
July	19½	20	.395	.406	.....		.....		12½	27	.253	.548
1861—January	19	19½	.385	.395	17½	38	.355	.771	19½	25	.395	.507
July	16	17	.324	.345	17½	38	.355	.771	19½	25	.395	.507
1862—January	16	16½	.324	.335	16	30	.324	.608	15	22	.304	.446
July	16½	17½	.335	.355	20	29	.406	.588	.....		.....	
1863—January	20	20½	.406	.416	18	26	.365	.527	15	20½	.304	.416
July	21	21½	.426	.436	15	27	.304	.548	15	22	.304	.446
1864—January		22½		.456	15	28	.304	.568	14	22	.284	.446
July	23½	24½	.477	.497	15	28	.304	.568	15	22	.304	.446
1865—January	24	25	.487	.507	16	27	.324	.548	15	22	.304	.416
July	20	21	.406	.426	17	28	.345	.568	14	20	.284	.406

* As quoted by the London Economist.

TABLE 13.—*Wholesale prices of wool in England since 1845*—Continued.

Date.	Wool, sheep's: English Southdown.		Wool, sheep's: Port Philip, lambs and fleece.				Wool, sheep's: South Australian lambs.			
	Per 240 pounds.	Per pound.	Per pound.		Per pound,		Per pound.		Per pound.	
			d.	d.			d.	d.		
1866—January ...	£21 to £22	$0.426 to $0.446	15 to	24	$0.304 to	$0.487	15 to	20	$0.304 to	$0.406
July	17	.345	14	27	.284	.548	15	22	.304	.446
1867—January ...	19	.385	16	28	.324	.568	15	22	.304	.446
July	16½	.335	16	28	.324	.568	15	22	.304	.446
1868—January ...	14½	.294	14	26	.284	.527	12	20	.243	.406
July	16	.324	14	26	.284	.527	13	20	.264	.406
1869—January ...	15½	.314	16	23	.324	.466	10	16	.203	.324
July	14	.284	11	23	.223	.466	9	16	.183	.324
1870—January ...	13½	.274	12	25	.243	.507	9	16	.183	.324
July	12¼	.248	13	25	.264	.507	9	16	.183	.324
1871—January ...	13	.264	11	22	.223	.446	8	15	.162	.304
July	16	.324	14	25	.284	.507	9	12	.183	.243
1872—January ...	21½	.436	15	27	.304	.548	12	19	.243	.385
July	22	.446	18	30	.365	.608	15	23	.304	.466
1873—January ...	23	.466	18	29	.365	.588	15	23	.304	.466
July	20	.406	17	28	.345	.568	14	22	.284	.446
1874—January ...	20¾	.421	16	28	.324	.568	15	22	.304	.446
July	15¾	.319	17	29	.345	.588	15	22	.304	.446
1875—January ...	18¼	.370	17	32	.345	.649	16	26	.324	.527
July	17	.345	16	30	.324	.608	14	22	.284	.446
1876—January ...	17½	.355	15	29	.304	.588	14	22	.284	.446
July	14½	.294	13	25	.264	.507	12	18	.243	.365
1877—January ...	16½	.335	17	31	.345	.629	16	24	.324	.487
July	14½	.294	14	28	.284	.568	14	28	.284	.568
1878—January ...	15½	.314	14	28	.284	.568	13	20	.264	.406
July	14¼	.294	14	28	.284	.568	13	20	.264	.406
1879—January ...	13	.264	14	24	.284	.487	13	18	.264	.365
July	11½	.233	14	24	.284	.487	13	18	.264	.365
1880—January ...	14½	.294	18	23	.365	.466	15	22	.304	.446
July	15½	.314	18	23	.365	.466	15	22	.304	.446
1881—January ...	15½	.314	17	20	.345	.406	18	21	.365	.426
July	12½	.253	17	19	.345	.385	17	19	.345	.385
1882—January ...	14	.284	18	19	.365	.385	17½	19	.355	.385
July	12	.243	18	20	.365	.406	18	20	.365	.406
1883—January ...	12	.243	18	20	.365	.406	18	20	.365	.406
July	11½	.233	18	19	.365	.385	18	20	.365	.406
1884—January ...	12½	.253	17	18	.345	.365	17	18	.345	.365
July	11	.223	16	17	.324	.345	16	13	.324	.365
1885—January ...	11¼	.228	16	17	.324	.345	16	18	.324	.365
July	10½	.213	16	17	.324	.345	16	18	.324	.365
1886—January ...	10½	.213	16	17	.324	.345	16	18	.324	.365
July	10½	.213	17	18	.345	.365	16	18	.324	.365
1887—January ...	12¼	.248	22	23	.446	.466	19	21	.385	.426
July	10½	.213	22	24	.446	.487	....		....	
1888—January ...	11¼	.228	21	23	.426	.466	....		....	
July	10¼	.208	20	22	.406	.446	....		....	
1889—January ...	11	.223		20		.406	....		....	
July	11	.223		*21½		*.436	....		....	
1890—January ...	12	.243		24		.487	....		....	
July	11¾	.238		20½		.416		†18½		†.375
1891—January ...	11½	.233		20		.406		18½		.375
July	12	.243		20½		.416		19½		.395
1892—January ...	12	.243		17¾		.360		17		.345
July	12	.243		18½		.375		16½		.335
1893—January ...	11¼	.228		17½		.355		17½		.355

* Good Viel, scoured.

† Cape scoured. Mr. North furnishes the following figures on Cape of Good Hope average scoured: 1892, 32 cents; 1893 and January and March, 1894, 30 cents.

TABLE 14.—*Relative prices of wool in England.*

[From pp. 223, 225, and 226, Part I, Senate report 1394, second session, Fifty-second Congress.]*

Year.	English, Southdowns, Port Philip lambs and fleece, and South Australia lambs. 1845—1850=100.	Wool, sheep's. 1860=100.	Year.	English Southdowns, Port Philip lambs and fleece, and South Australia lambs. 1845—1850=100.	Wool, sheep's. 1860=100.
1860	....	100	1878	122	84.8
1861	....	110·7	1879	109	75·9
1862	....	92·4	1880	117	85·7
1863	....	96·7	1881	120	86·3
1864	....	100·3	1882	108	82·3
1865	....	104·7	1883	106	78
1866	....	94·9	1884	98	74·9
1867	....	95·8	1885	92	71·8
1868	....	80·8	1886	90	70·5
1869	....	76·8	1887	116	87·2
1870	96	71	1888	111	76·4
1871	88	65·6	1889	107	71·5
1872	....	93·7	1890	120	82·7
1873	157	105·8	1891	102	79·8
1874	....	98·8	1892	98	74·9
1875	145	102·2	1893	94	74·1
1876	133	92·3	1894	94	....
1877	141	96·7			

* Except the figures for 1894, which are for January 1, and are from page 35 of the supplement to the London Economist for February 17, 1894.

The London Economist, in its annual trade supplement published with its issue of February 17, 1894, gives a review of the wool trade of 1893 by Helmuth, Schwartze & Co., of London, in which there is a table showing the prices on December 31, 1893, in comparison with those for the same date in four preceding years. The figures there given, with their equivalent in cents at the rate of 2 cents per penny, are presented in the following table:

TABLE 15.—*English prices of wool in 1893 compared with prices in four preceding years.*

	Mean point.		Value per pound on Dec. 31—									
			1893.		1892.		1891.		1890.		1889.	
	d.	*cts.*	*d.*	*cts.*	*d.*	*cts.*	*d.*	*cts.*	*d.*	*cts.*	*d.*	*cts.*
Australian P. P., good average greasy	10½	21	8½	17	8½	17	9	18	10	20	12	24
Australian P. P., good average scoured combing	*18¾	37½	15½	31	15½	31	16½	33	18	36	21	42
Australian, Sydney, average greasy (short)	8¾	17½	7	14	7	14	7½	15	8½	17	10	20
Australian, Adelaide, average greasy	7½	15	5¾	11½	6	12	6¼	12½	7½	15	9	18
ustralian, New Zealand, super greasy	10¾	21½	8½	17	9	18	9	18	11	22	12½	25
Custralian, crossbred, super greasy (fine)	12½	25	11½	23	12	24	12½	25	13	26	14½	29
Custralian, crossbred, average greasy B(medium)	10	20	9½	19	9½	19	9½	19	10	20	11	22
Cape, Eastern, extra super snow-white	18	36	15½	31	15½	31	16½	33	18	36	21	42
Cape, Eastern, average fleece	9¼	18½	7¾	15½	7¾	15½	8	16	8½	17	11	22
Buenos Ayers, good average greasy combing (35 per cent)	*6⅜	12¾	5⅝	11¼	5⅞	11¾	6	12	7	14	8¼	16½
Buenos Ayres, average greasy (30 per cent)	5⅜	10¾	4⅝	9¼	4⅞	9¾	5	10	5¾	11½	6¾	13½
Peru, middling	8⅛	16¼	7	14	7¾	15½	7¾	15½	8½	17	*8½	17
Donskoi, average white carding	7½	15	7	14	6¾	13½	7	14	7¼	14½	7½	15
East India, Pac Pathan, yellow	7¼	14½	6¾	13½	7	14	7¼	14½	8¼	16½	8¼	16½
Lincoln, hogs	[illegible]	23¼	10¾	21½	9½	19	*9⅛	18¼	10¼	20½	14	28
Alpaca, Isla super fleece	18½	37	14½	29	14½	29	12½	25	15	30	22	44
Mohair, Turkish, fair average	16½	33	15½	31	14½	29	12¾	25½	14	28	19	38

* In these quotations the fractions were so indistinctly printed, that there is some uncertainty as to their correctness as here reproduced.

The Canadian wools, according to a statement of the secretary of the National Association of Wool Manufacturers, are mostly combing wools of English blood, which rarely reach our markets. The annual report of the Bureau of Industries of Ontario for 1892 gives the average prices for the principal markets of that province from 1882 to 1892, inclusive, as follows:

TABLE 16.—*Average prices of wool in Ontario, Canada.*

Year.	Price per pound.	Year.	Price per pound.	Year.	Price per pound.
	Cents.		*Cents.*		*Cents.*
1882	16.9	1886	19.1	1890	20.5
1883	16.9	1887	22.1	1891	19.4
1884	17.8	1888	20.4	1892	18.2
1885	17.4	1889	20.7	1882-'92	18.8

TRANSPORTATION RATES.

No change has been made in the transportation rates on the trunk lines between Chicago and New York for the past year. Only a few unimportant changes during the year are noted by the Delaware and Western Railroad, from New York to Buffalo. A few inappreciable changes on the same railroad from New York to Chicago are given for the year. The same might be said for the same road from New York to East St. Louis. On the Grand Trunk Railway, Chicago to Boston, a general decline in rates from January 1, 1892, to September 1, same year, is quoted. From the latter date to January 1, 1893, the tariff was generally maintained, with the exceptions of beef in barrels per 100 pounds, from 28 cents to 33 cents; the same change for hams per 100 pounds; hops in bales, per 100 pounds, declined from 71 cents to 55 cents (this from September to October 1). A rate on hay was given for the first time on August 1, 1893, of 27 cents per 100 pounds. No material changes were made during 1893. On the Grand Trunk Railway, Detroit to Boston, there was an average decline of a cent and one-half on forty-seven articles from January 1 to August 1. On September 1 the lower rates prevailing on January 1 were resumed and continued without change to the end of the year. Rates on hay were given for the first time. The figures were $24\frac{1}{2}$ cents per 100 pounds on August 1, but fell to $21\frac{1}{2}$ cents on September 1. There were no changes in tariffs during the year on the Chicago, Milwaukee and St. Paul Railway. Very few changes on the Northern Pacific Railway are noted. A decline of 3 cents per 100 pounds on flour, potatoes, and flax on this line between Duluth and Bismarck, N. Dak., is quoted. A few changes on the Chicago, Burlington and Quincy Railroad, St. Louis from Omaha and Council Bluffs, were made in 1893. Cattle, sheep, and hogs were advanced from $14\frac{3}{4}$ to 20 cents, $17\frac{1}{2}$ cents to $21\frac{1}{2}$ cents, and 15 cents to $18\frac{1}{2}$ cents per 100 pounds, respectively. This advance was made in February and continued to the end of the year.

This road gives for the first time the rate on hay, viz, 15 cents per 100 pounds. The same system to St. Louis from Atchison, Kansas City, or St. Joseph, reported a small number of changes in February and resumption in March of the January rates. The same rate for hay is quoted for the first time as above. No material change on this system to Chicago from Omaha or Council Bluffs. Hay per 100 pounds

is given for the first time at 20 cents. The same may be said for the branch of this extensive system from Atchison, Kansas City, or St. Joseph to Chicago. The Chicago and Alton Railroad, to Chicago from East St. Louis, reports no changes in rates for 1893. The inceptive figures for hay are 10·9 cents per 100 pounds, C. L., and 29 cents L. C. L., per 100 pounds. No material change on this line between Chicago and Kansas City is noted, except a decline of $5 per carload of horses. On the same system, to Chicago from Kansas City, some changes in July are reported. The changes are about equally divided between plus and minus. The increases are apples, per 100 pounds, 15 cents, to 25 cents; cotton, pressed in bales, per 100 pounds, from 40 cents to 75 cents; and the decreases are butter, C. L., per 100 pounds, from 60 cents to 42 cents, and hogs, per 100 pounds, from 25 cents to 22 cents. Rates on hay are given for the first time at 20 cents per 100 pounds, C. L., and 42 cents, per 100 pounds L. C. L. The July figures were continued to December. On this same system, between East St. Louis and Kansas City, several changes are noticed, notably a decrease from 32 cents to 25 cents per 100 pounds of apples, L. C. L.; also butter, same amount, from 40 cents to 32 cents; cotton advanced from 25 cents to 55 cents on the 100 pounds, pressed in bales, L. C. L., and from 32 to 55 cents. Rates on hay for the first time were given at 15 cents per 100 pounds, C. L., and 32 cents per 100 pounds, L. C. L. A very few immaterial changes were made on the Louisville and Nashville from Louisville to New Orleans. Hay was quoted for the first time, and the figures were 20 cents per 100 pounds, C. L. Only three changes were made by the Chesapeake, Ohio and Southwestern Railroad, and they were reductions of 13 cents per 100 pounds on flax, hemp, and manila, or sisal. Rates to San Francisco and other Pacific coast terminals from Kansas City, St. Paul, St. Louis, New Orleans, Chicago, and Milwaukee for 1893 show a general decline compared to 1892, and the same holds good for eastern rates from the same points to the cities named.

An inspection of the table showing the all-rail rates, Chicago to New York, will be found interesting and instructive. It will disclose a steady decline in rates per bushel of corn and wheat since 1870.

The table giving the yearly average rates on wheat per bushel, New York to Liverpool, shows a material reduction within the last decade.

LAKE AND CANAL RATES ON WHEAT AND CORN FROM CHICAGO.

During the season of lake navigation a large proportion of the grain traffic is carried from Chicago by the lakes, connecting with the Erie Canal at Buffalo.

A table is here given showing the weekly range of the rates upon wheat and corn, Chicago to Buffalo via lakes; Buffalo to New York via Erie Canal, and the through rates, Chicago to New York, less the transfer charges at Buffalo, for the years 1891, 1892, and 1893:

Lake and canal rates on wheat and corn.

[In cents per bushel.]

Week ending—	Lake—Chicago to Buffalo.						Erie Canal—Buffalo to New York.						Lake and canal—Chicago to New York.					
	1891.		1892.		1893.		1891.		1892.		1893.		1891.		1892.		1893.	
	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.
May 10	1⅜	1⅛	2	1¾	1	1	2¾	2¼	2⅞	2½	4½	4⅛	4⅛	3⅜	4⅞	4¼	5½	5⅛
17	1¼	1⅛	2	1¾	1¼	1⅛	2½	1⅞	2¼	2	4½	4⅛	3¾	3	4¼	3¾	5¾	5¼
24	1	1	1¾	1½	1½	1⅜	2½	2	2½	2¼	5	4⅝	3½	3	4¼	3¾	6½	6
31	1	1	1½	1¼	1½	1⅜	3¼	2¾	2½	2¼	5	4⅝	4¼	3¾	4	3½	6½	6
June 7	1	1	1½	1¼	2¼	2	3	2½	2¼	2	5	4⅝	4	3½	3¾	3¼	7¼	6⅝
15	1	1	2	1¾	2¼	2	3	2½	2¼	2	5¼	4¾	4	3½	4¼	3¾	7½	6¾
22	1	1	2	1¾	1½	1¼	2⅞	2¾	2¼	2	4½	4⅛	3⅞	3¾	4¼	3¾	6	5⅜
30	1½	1¼	2	1¾	1	1	2¾	2⅜	2¼	2	4¼	3⅞	4¼	3⅝	4¼	3¾	5¼	4⅞
July 7	1½	1⅜	2	1¾	1	1	2¾	2⅜	2¼	2	4½	4⅛	4¼	3¾	4¼	3¾	5½	5⅛
14	2	1¾	2	1¾	1	1	2½	2¼	2½	2⅛	4½	4⅛	4½	4	4½	3⅞	5½	5⅛
22	2	1⅞	2	1¾	1⅝	1½	2½	2¼	2½	2⅛	5	4½	4½	4⅛	4½	3⅞	6⅝	6
29	2¼	2¼	2	1¾	1¼	1	3½	3¼	2¾	2¼	5	4⅝	5¾	5½	4¾	4	6¼	5⅝
Aug. 7	3¼	3	2½	2¼	1¼	1	3¾	3⅜	2⅝	2⅜	5	4⅝	7	6⅜	5⅛	4⅝	6¼	5⅝
15	2¾	2¼	2¼	2	1¼	1	3⅞	3⅜	3	2⅝	4⅞	4½	6⅝	5⅝	5¼	4⅝	6⅛	5½
23	2¾	2½	2¼	2	1½	1¼	4	3⅝	3⅜	3	4	3⅝	6¾	6⅛	5⅝	5	5½	4⅞
30	2½	2¼	2¼	2	1½	1¼	4	3⅝	3	2⅝	4⅜	4	6½	5⅞	5¼	4⅝	5⅞	5¼
Sept. 7	3¼	3	2¼	2	1⅝	1⅜	4	3½	4	3½	3⅝	3⅜	7¼	6½	6¼	5½	5¼	4¾
15	3½	3¼	2½	2¼	1½	1⅜	4¼	3⅞	3⅞	3½	3¾	3½	7¾	7⅛	6⅜	5¾	5¼	4⅞
22	3¾	3½	2½	2¼	1⅝	1½	4	3⅝	4	3⅝	4½	4⅛	7¾	7⅛	6½	5⅞	6⅛	5⅝
29	3	2¾	2¼	2	2½	2¼	4½	4⅛	4	3⅝	4¼	3⅞	7½	6⅞	6¼	5⅝	6¾	6⅛
Oct. 7	2	1¾	2½	2¼	2¼	2	4½	4⅛	4¼	3⅞	4	3⅝	6½	5⅞	6¾	6⅛	6¼	5⅝
14	2	1¾	2½	2¼	2	1¾	4⅜	4	4⅜	4	5	4⅝	6⅜	5¾	6⅞	6¼	7	6⅜
22	2	1¾	2¼	2	2⅜	2	4¾	4¼	5	4⅝	5	4⅝	6¾	6	7¼	6⅝	7⅜	6⅝
29	2½	2¼	2¼	2	2	1¾	4½	4	6	5⅝	5½	5	7	6¼	8¼	7⅝	7½	6¾
Nov. 7	4	3¾	3	2½	1¾	1½	4¼	3¾	5	4⅝	5	4⅝	8¼	7½	8	7⅛	6¾	6⅛
15	4	3¾	2¾	2½	2	1¾	3¾	3½	4	3¾	4¾	4½	7¾	7¼	6¾	6¼	6¾	6¼
22	4	4	2½	2	2	1¾	4	3½	4	3¾	5	4½	8	7½	6½	5¾	7	6¼
30	4½	4¼	2½	2½	2¾	2½	4¼	3¾	5	4	....	....	8¾	8	7½	6½	....	....

TRANSATLANTIC RATES—TABLES SHOWING YEARLY AVERAGE RATES FOR 1892 AND 1893.

Articles.	New York to Liverpool, yearly average rates.	
	1892.	1893.
Wheat and corn ... per bushel	$\$0.05\frac{4}{5}$	$\$0.04\frac{3}{5}$
Flour ... per barrel	.41	$.38\frac{3}{4}$
Bacon ... per 2,240 pounds	4.20	3.89
Lard ... do	3.68	3.31
Beef ... per tierce	$.69\frac{1}{2}$	.65
Pork ... per barrel	.50	.44
Apples ... do	.57	.60
Butter ... per 2,240 pounds	6.82	6.75
Cotton ... per pound	$.00\frac{17}{64}$	$.00\frac{15}{64}$

Articles.	Boston to Liverpool, yearly average rates.	
	1892.	1893.
Wheat and corn ... per bushel	$\$0.05$	$\$0.04\frac{1}{2}$
Flour ... per barrel	.40	.34
Flour, in sacks ... per ton	2.56	2.04
Bacon ... do	3.51	2.77
Beef and pork ... per barrel	.54	.46
Butter ... per ton	4.61	3.74
Lard ... do	3.35	2.74
Apples ... per barrel	.48	.40
Cattle ... per head	11.05	8.33
Cotton ... per pound	$.00\frac{16}{64}$	$.00\frac{13}{64}$

The following comparative table is given to show the monthly average rates upon a few of the more important articles of export from New York to Liverpool, as compiled from the returns of the steamship companies, for 1892 and 1893:

Articles.	January.		February.		March.		April.	
	1892.	1893.	1892.	1893.	1892.	1893.	1892.	1893.
Wheat and corn .... per bushel..	\$0.09	\$0.03	$\$0.07\frac{1}{2}$	\$0.03	$\$0.07\frac{2}{3}$	\$0.03	$\$0.06\frac{1}{4}$	\$0.03
Flour .... per barrel..	.60	.24	.56	.24	.48	.24	.34	.36
Bacon .... per 2,240 pounds..	6.00	3.00	5.20	3.00	4.80	3.60	4.80	3.60
Lard .... do....	5.30	2.40	4.60	2.40	4.80	2.40	4.05	2.40
Beef .... per tierce..	1.08	.48	.92	.42	.80	.42	.78	.24
Pork .... per barrel..	.78	.30	.62	.24	.62	.30	.54	.36
Cotton .... per pound..	$.00\frac{25}{64}$	$.00\frac{5}{32}$	$.00\frac{5}{16}$	$.00\frac{5}{32}$	$.00\frac{5}{16}$	$.00\frac{3}{16}$	$.00\frac{9}{32}$	$.00\frac{3}{16}$
Apples .... per barrel..	.72	.60	.60	.60	.50	.54	.51	.54
Butter .... per 2,240 pounds..	8.00	4.80	7.20	4.80	7.20	4.80	7.20	4.80

Articles.	May.		June.		July.		August.	
	1892.	1893.	1892.	1893.	1892.	1893.	1892.	1893.
Wheat and corn .... per bushel..	$\$0.05\frac{1}{3}$	$\$0.03\frac{3}{4}$	$\$0.04\frac{1}{8}$	$\$0.04\frac{1}{4}$	$\$0.04\frac{5}{8}$	$\$0.06\frac{1}{2}$	$\$0.05\frac{1}{4}$	\$0.07
Flour .... per barrel..	.36	.33	.36	.42	.34	.48	.36	.48
Bacon .... per 2,240 pounds..	3.60	3.00	3.60	2.70	3.60	4.80	3.60	4.65
Lard .... do....	3.00	2.40	3.00	2.70	3.00	4.50	2.90	4.35
Beef .... per tierce..	.56	.48	.56	.48	.60	1.14	.56	.84
Pork .... per barrel..	.42	.33	.42	.33	.42	.54	.40	.54
Cotton .... per pound..	$.00\frac{3}{16}$	$.00\frac{13}{64}$	$.00\frac{1}{4}$	$.00\frac{11}{64}$	$.00\frac{15}{64}$	$.00\frac{9}{32}$	$.00\frac{3}{16}$	$.00\frac{17}{64}$
Apples .... per barrel..	.52	.60	.48	.54	.56	.66	.60	.60
Butter .... per 2,240 pounds..	6.00	4.80	7.20	6.00	7.20	8.40	6.80	8.40

Articles.	September.		October.		November		December.	
	1892.	1893.	1892.	1893.	1892.	1893.	1892.	1893.
Wheat and corn .... per bushel..	$\$0.03\frac{2}{3}$	$\$0.06\frac{3}{4}$	$\$0.05\frac{1}{3}$	$\$0.04\frac{1}{4}$	$\$0.06\frac{1}{2}$	$\$0.05\frac{1}{3}$	\$0.04	\$0.06
Flour .... per barrel..	.34	.48	.39	.42	.45	.48	.36	.48
Bacon .... per 2,240 pounds..	3.00	4.80	3.60	3.90	4.40	4.20	4.20	5.40
Lard .... do....	2.30	4.50	3.20	3.30	4.00	3.60	4.00	4.80
Beef .... per tierce..	.48	.90	.60	.66	.76	.78	.64	.96
Pork .... per barrel..	.34	.60	.44	.51	.58	.54	.46	.72
Cotton .... per pound..	$.00\frac{9}{64}$	$.00\frac{17}{64}$	$.00\frac{9}{32}$	$.00\frac{1}{4}$	$.00\frac{19}{64}$	$.00\frac{11}{32}$	$.00\frac{15}{64}$	$.00\frac{11}{32}$
Apples .... per barrel..	.60	.66	.60	.60	.60	.66	.60	.66
Butter .... per 2,240 pounds..	5.60	9.00	6.00	8.40	6.80	7.80	6.60	9.00

REPORT OF THE SPECIAL AGENT IN CHARGE OF FIBER INVESTIGATIONS.

SIR: I have the honor to present herewith a report upon the principal operations of the Office of Fiber Investigations for the year 1893.

Very respectfully,

CHAS. RICHARDS DODGE,
Special Agent in Charge.

HON. J. STERLING MORTON,
Secretary.

INTRODUCTORY.

During the greater part of the year this office was chiefly occupied with matters relating to the World's Columbian Exposition, which seriously interfered with the regular functions of the division. The work of investigation was not discontinued, however, and the season has shown some interesting results. Satisfactory progress has also been made by those who have a commercial interest in the success of these new industries.

A considerable amount of material, the results of previous investigations, has not yet been worked up for publication, although the results are now being prepared, and will be presented in due time. It has been the aim of the special agent in charge to eventually cover the entire field of American fiber production—actual and possible—in order to provide such complete literature of the subject that all general inquiries relating to American fibers may be answered by the bulletins alone, leaving the details of inquiry to special correspondence. There are several fiber plants concerning which further authoritative information is most desirable, as their production or utilization will open up new industries, particularly in the South, where there is such need of diversity in agricultural production. Among these, especial mention may be made of jute, ramie, pineapple fiber, and the palmettoes, past investigations into the cultivation or utilization of these fibers, with the exception of ramie, having been only preliminary. Further investigation regarding these plants has been a part of the scheme of unfinished work of this office. The public interest in possible fiber industries in the United States has not abated, but has recently developed in new and important lines.

THE FIBER EXHIBIT OF THE DEPARTMENT AT CHICAGO.

The experimental work of the Office of Fiber Investigations for three years, beginning with 1890, made it possible to bring together at Chicago what was probably the largest and most complete American exhibit of fibers ever before displayed in one collection. In the scheme of arrangement and presentation it was aimed to show in series all the fibers that are at present growing, or that may be cultivated, in the United States, together with the commercial fibers imported for actual manufacture in this country and to supplement each group as far as possible with leading forms of manufacture to illustrate the uses of the fiber. Each species, therefore, was shown in series, from the crudest form of the product, as the rough, harvested stalks, through the different operations and processes, up to the highest form of the prepared fiber; and lastly, the manufactures.

Special attention was paid to the installation of the 530 specimens thus brought together. It was considered an advantage to exhibit the raw fiber in full length, in mass, and for this purpose upright boxes were prepared that were 5 feet high, or divisions of 5 feet, and from 6 inches to 18 inches wide. These were subsequently placed in cases $7\frac{1}{2}$ feet high, glazed with plate glass, and painted white, the boxes themselves lined with glazed blue paper. It should be noted that this color scheme produced the best possible effect in displaying fibrous products, and is the result of experience and of the study of other collections at former exhibitions in this country and in Europe.

While a typical American fiber exhibit, it was also a practical object illustration of the work of the Office of Fiber Investigations, the reports of the office, which were always available, supplying the descriptive matter, or text, for a comprehensive study of the collection by those desiring to make more than a casual examination.

A description of the flax series will illustrate the scheme of arrangement of the entire exhibit. This was the largest exhibit of a single form of fiber, as it was deemed important to display examples of straw grown in the principal sections of the country where flax may be produced, the specimens exhibited also showing the results of the department's flax cultural experiments of 1891. Straw was shown that was produced in States from Massachusetts to California and Oregon, the latter examples being especially fine, and capable of producing a high-grade fiber. Following the straw samples was a large exhibit of the prepared fiber showing the results of many careful experiments, and different forms of practice, for the most part secured from Mr. Eugene Bosse, of St. Paul Park, Minn., and produced chiefly in Minnesota and Wisconsin. Further on in the series, a part of the same fiber was shown manufactured into crash. The linen series was especially interesting, the main exhibit being a lot of several hundred yards of bleached and brown linen, draped and in bolts, specially spun and woven for the Department without cost, by the Stevens Linen Mills at Webster, Mass. A second interesting exhibit was donated by the Sioux Falls (South Dakota) Linen Mills, the fabrics having been produced from flax grown in that State. Contrasted with this exhibit was a valuable series of straw, dressed line, and fabrics from Lee County, Va., collected by the Special Agent in Charge, and illustrating the household-linen manufacture of our grandfathers' days. A spinning wheel and check reel were also shown.

This exhibit was still further supplemented by a large collection of

imported flax, many countries being represented, to show the farmer the kinds of flax with which he must compete, and at the same time to illustrate the raw product employed in American flax manufacture, the manufactures themselves being shown. This collection filled three large cases, each specimen being marked with a label printed in plain type, giving all necessary information regarding the sample. Such an object lesson in American flax culture, preparation, and manufacture was never before presented. The flax publications of the Office of Fiber Investigations are Reports Nos. 1 and 4.

It should be observed that in the scientific arrangement of the entire fiber collection the exhibits were separated into two divisions, the bast fibers, and the leaf and palm fibers.

Following flax in the first division came the cultivated bast fibers, such as hemp, jute, and ramie, the display of the latter being especially beautiful, as it included a case 22 feet long filled with exquisite fabrics, in great variety, loaned by the manufacturers, Messrs. Jones & Warr, of Paterson, N. J. Hemp, jute, and ramie are considered in Fiber Reports Nos. 1 and 2.

The uncultivated bast fibers, or indigenous species of fibrous plants that have been the subject of experiment in the United States, filled another case. These will be fully treated in Report No. 6, issued from the Office of Fiber Investigations. Among the species shown were "American jute," so-called, the product of *Abutilon avicennæ; Asclepias incarnata*, or swamp milkweed; *Urtica gracilis*, or stinging nettle; several species of *Hibiscus*, such as the swamp rose mallow, okra, etc.; *Apocynum cannabinum*, Indian hemp; *Sesbania macrocarpa*, Colorado River hemp, with the Texas species, *S. vesicaria;* and other less important species. Cotton-stalk fiber was also shown in this case.

In the second division, or leaf fibers, was shown a large series of samples of fiber produced in the Department's experiments in Southern Florida in 1892, with sisal hemp, bowstring hemp, pineapple and other leaf fibers, the records of which will be found in Fiber Reports Nos. 3 and 5. A striking feature of this exhibit was the arrangement side by side of the sisal hemps from Florida, the Bahamas, and Yucatan, affording opportunity for a comparison of the fibers of these localities. That the Florida fiber is superior to the commercial fiber as imported from Yucatan there is no question, and its length is better than that from the Bahamas. This means that it is worth more per pound in the market, and to that extent would make a more profitable industry. The bowstring and pineapple fibers are most interesting as illustrating the possibilities of two wholly new fiber industries in the South, while a series of samples of New Zealand flax from California shows what might be done with leaf fibers on the Pacific Coast.

The Yucca fibers are also interesting. Some of the species of Yucca sent to the Department from the southwest are long enough for cordage fiber, and might be employed with advantage for local uses in the localities where grown. Ixtle and manila fiber will doubtless never be produced within the borders of the United States. These fibers are employed to a very large extent in manufacture, however, in this country, and the two series are interesting.

The palm fibers are represented by the cocoanut, and two species of palmetto, growing chiefly in the State of Florida, the palmettoes supporting several valuable fiber industries in that State. The cocoanut tree is not grown for fiber, though the trees thrive in many portions of sub-tropical Florida. The largest tract of cocoanut trees,

numbering over 17,000, is found on Long Key, and was planted about eight years ago.

Among the miscellaneous exhibits worthy of mention was a series illustrating the use of the leaves or "needles" of *Pinus australis* in the manufacture of a fiber that is employed for bagging, carpets, and upholstery. A collection of crude Spanish Moss, and upholstery fiber made from it, and a fiber derived from the native bamboo of the Southern States (*Arundinaria tecta*) were especially interesting.

The entire wall space of the exhibit was bordered by a frieze composed of bromide enlargements of photographs illustrative of the cultivation and manufacture of leading American fibrous plants; these were some thirty in number. At the close of the Exposition the entire exhibit was turned over to the New Columbian Museum, Chicago, as a loan collection, where it will be preserved in its entirety, in the original cases.

THE PRODUCTION OF JUTE.

There is no doubt as to the practicability of growing jute as a crop in the Gulf States. Whether the fiber can be produced profitably in competition with the India product is a matter for experiment to determine, the question of its economical extraction entering largely into the problem. It has already been demonstrated that fine crops of jute may be grown in Texas and Louisiana, but we can only approximate vaguely the cost of a crop to the grower, and the precise cost of preparation is equally a matter of doubt. These questions settled satisfactorily, there is no doubt as to the success of the industry, as there is already a large demand for the fiber, our importations of India jute alone reaching the value of $3,000,000 in a single year. The fiber is chiefly used in baling the cotton crop of the Southern States, in cordage and burlaps, and to some extent in higher manufactures, such as table covers, furniture coverings, etc.

At the machine trials of 1892, conducted at New Orleans under the direction of this office, it was demonstrated that the stalks yield readily to treatment, the ribbons being easily retted in water in a few days, owing to the extreme solubility of the gums holding the filaments together in the bast. An illustration (Plate I) of a row of growing jute stalks at the Louisiana Experiment Station, Audubon Park, La., is presented, showing the rank growth made by the plant under ordinary conditions of culture. The Indian method of extracting the fiber is to ret the stalks in water, like hemp, for a certain period, after which the fiber is thrashed off by striking a handful of stalks violently upon the surface of the water in the pools where retted. In this country such rude practices can not be followed, however, and the work must be facilitated by the use of a mechanical stripping of the bark. The cost of culture and of the subsequent operations, therefore, should be ascertained by careful experiments in order that we may know to what extent planters should engage in the industry.

Some beautiful specimens of American jute fiber, grown by the Felix Fremerey Decorticator Company, near Galveston, Tex., were shown in the Department exhibit at Chicago. The fiber is of good color and strength, one specimen, extra cleaned, being of fine quality, that doubtless would command a much higher price in the market than the imported material. As comparatively little has been published by the Department on this subject, a special bulletin on jute culture is being prepared which will be ready for transmittal in due time.

JUTE CULTIVATION IN LOUISIANA.

PROGRESS IN THE RAMIE INDUSTRY.

The interest in this wonderful fiber is increasing, rather than diminishing, and the records of progress in the past two years, since the last ramie bulletin was published by this office, are so valuable that it is important to bring the matter down to date. But as this is hardly possible in the limits of an annual report, we can only note briefly a few points relating particularly to our own country, and leave details for the bulletin that is being prepared.

MACHINES FOR DECORTICATING RAMIE FOR FIBER TRIALS.

The interest attaching to the problem of economically decorticating the fiber of ramie, as is well known, has stimulated invention in both the new and old worlds during a period of twenty-five years or more. The official trials in India, the trials of 1888 in Belgium, and of 1889 and 1891 in France are matters of history. In our own country there have been many attempts to produce an economically successful machine, and in the past few years probably a dozen machines have been brought to the attention of the public as possessing merit.

Records of private trials of American machines and of foreign machines brought to this country have been forwarded to the Office of Fiber Investigations of the Department from time to time, but the results did not give the information desired by the Department as to the capacity of the machines or their utility in continuous operation. A point which can not be overlooked is the fact that the records of private trials that are published by interested parties are liable to be considered in the light of advertisements, while the records of an official trial are at once authoritative, as the trial is made under specified rules and by a board of wholly disinterested persons. The advantage of government trials in Europe and elsewhere has been recognized by all whom they interest, and it is only through these trials, as new machines are developed, that it has been possible to note the progress in the construction of decorticating devices.

The importance of authoritative knowledge regarding American inventions resulted in the first official trial of ramie machines held in the United States, which took place at Audubon Park, New Orleans, in September, 1892. Three of the leading machines of American invention at that time were entered for competition. These were given rigid tests under prescribed rules by a special board of experts, resulting chiefly in bringing out defects of construction rather than the establishing of records of capacity for American machines. Scarcely more was accomplished at the early trials of ramie machines by the French Government, though in these trials beginnings were recorded by means of which subsequent progress has been marked. One result of the early French trials has been to stimulate invention, and the same may be said of our own efforts. But it is not to machinery alone that we look to overcome the difficulties in the decortication of ramie, for it is possible that the final result may be reached by a "process" or by the combination of a process with some mechanical device for the separation of bast and wood. In Europe considerable has been accomplished in the past two years, and it should be noted that the manufacturers of two foreign machines have sufficient faith in their decorticators to be willing to send them across the water to try them on American ramie.

THE PROCESS OF DEGUMMING RAMIE.

In the degumming of ramie there is no doubt that the best American processes will accomplish the result more cheaply and satisfactorily and with less waste than the foreign processes of which we have information at present. The beautiful exhibit of degummed fiber, prepared by Mr. W. T. Forbes from ribbons cleaned at the trials in New Orleans, and exhibited in the Department collection at Chicago, demonstrates that the fiber of American-grown ramie is strong and good. When the ribbons produced at the New Orleans machine trials were to be prepared it was the intention of this office to ascertain the approximate yield of degummed fiber to the ton of dried ribbons, to give a basis of comparison between American machine-cleaned ramie and the China-grass of commerce. The bulk of the ribbons were carefully weighed and were sent to the inventor of a degumming process, who was at that time in correspondence with the Department, but the fiber was so carelessly treated that it was worthless for any purpose. Subsequently, a very small lot of ribbons, reserved for samples, was treated by Mr. Forbes, but it was too small to take into account to determine ratio of finished American fiber to raw material, and the opportunity to demonstrate this point was lost. Such an experiment should be undertaken the present season, if possible, as it forms an important factor in the question whether or not it will pay to grow ramie in the United States.

It is reported that the Forbes Fiber Company has recently located a large factory in Jersey City for the degumming of ramie, and that manufacturers are ready to take at good prices all the material the concern can produce. As a matter of course the imported fiber will be the raw material used, and it is now claimed that contracts can be made in China for almost any amount of the raw product. The lowest market price of this fiber at the present time is $6\frac{1}{2}$ cents per pound. It is a question, however, if this price can be sustained with an active demand. Recent correspondence with leading fiber brokers of Europe would seem to show that the matter of a large supply is simply a question of price, possibly $8\frac{1}{2}$ cents per pound.

Some interesting figures have been tabulated showing the cost of degumming abroad, and it is hoped that by the time the forthcoming ramie bulletin is published figures relating to degumming in the United States will have been secured for comparison with the foreign statements.

CHARACTER OF GREEN RAMIE.

Referring again to the New Orleans machine trials, a point demonstrated beyond any doubt at these trials was the perishable nature of green ramie, either stripped of its leaves or unstripped, and the experience emphasizes the importance of taking the machine into the field where decortication in the green state is carried on. Two or three small bundles of ramie stalks with leaves, cut and tied up on the Willet plantation before noon of the 29th, had begun to show signs of heating on the morning of the 30th, though the stripped stalks and remainder of the unstripped stalks were in perfect condition. The writer stated in his conclusions, when the report of the board of experts was presented, that it was an interesting point for future experiment to determine whether ramie stalks can be perfectly dried in best condition for machine working in Louisiana, owing to the greater humidity of this section compared with other sections of the country suitable to ramie culture.

It was further suggested that, in view of the difficulties in the way

of proper sun-drying, slight kiln-drying might render the stalks sufficiently brittle to work properly in the machine when the dry system of decortication was employed. Since the publication of that report and during the past season Louisiana experimenters have gained valuable experience on this point which may result in an entirely new departure in the handling of ramie stalks, as the two extremes of difficulties will be avoided, viz, the danger of fermentation and mildew in the green stalks, with the subsequent setting of the gums in after drying, on the one hand, and the expense of reducing the gummy matter in fiber that has been stripped from a kiln-dried stalk on the other hand. A sample of machine-cleaned fiber from dry stalks has recently been received from Mr. S. B. Allison, of New Orleans, which is claimed to yield the degummed fiber with a loss of only about 44 per cent in weight. The sample is similar in appearance to the samples turned out by the Favier dry-system machine at the Paris trials of 1889, more or less of the pellicle adhering. Mr. Allison hopes in time to produce fiber with all of the pellicle removed.

The present machine is controlled by the American Fiber Company of New Orleans. At a private trial held in New Orleans, August, 1893, an hour's run on 351 pounds of dried stalks, two years old, gave a product of 160 pounds of dry fiber. As the Government expert was not present at the running, and all the conditions are not known, the record can be presented in these pages only as a statement of the company, and not as an authoritative official report.

RAMIE MANUFACTURES.

In a communication from Mr. de Landtsheer, of France, it is suggested that the dry-system fiber can be employed in cheaper manufactures without degumming, as it will be possible to card it from the machine direct without subsequent treatment, and that a special industry might be created by employing this fiber, which would supply a market that farmers could satisfy. Mr. Forbes has made a similar suggestion, indicating the possibility of creating such an industry in the United States which would in nowise interfere with the degumming industry. This fiber, which is somewhat lighter than jute, could be wrought into fine twines of great strength—fish lines, nets—and even into fabrics for coarse uses where strength would be a greater consideration than appearance and finish. The Southern States and California would be greatly benefited by such an industry, which is not beset with the difficulties attending the use of American-grown fiber in the higher grades of manufacture that necessitate large outlay for degumming and combing, with a considerable waste or noils. Persistent effort on the part of Government and private corporations must eventually place the ramie industry beyond the stage of experiment and upon a paying basis, and it is encouraging that progress is being made in this direction steadily and surely.

In the field of fine ramie manufacture some very interesting results have recently been reached, among which may be mentioned a collection of beautiful ramie goods of American fabrication which formed a portion of the fiber exhibit of the Department at Chicago. They were loaned by Messrs. Jones & Warr, of Paterson, N. J., the collection comprising fine yarns, both white and dyed, fish lines, cloths, toweling, hangings, chenille, ramie-silk goods, and laces. And in this exhibit was a piece of pure ramie belting, 3 inches wide, which stood a strain

of 1 ton without rupture. This office is informed that arrangements are being completed to place these goods on the market in the near future.

Since the publication of the last report the writer has received from Mr. Favier some interesting statements concerning the operations of the new French manufacturing company, founded on the old "La Ramie Francaise." The statement has been made that the factory employs 200 people, and that the business amounts to nearly $200,000 annually. Chinese ramie is employed, and the products principally manufactured are linen and thread, though Mr. Favier has produced other beautiful materials. The ramie-linen goods are in particular demand on account of the great resistance of the fabric to wear and to the effect of repeated washings. The most important railways and hotels have adopted this fabric, and the city of Paris uses it in the service of its twenty districts. It is ordered for the dressing of wounds in several hospitals, including those of the army and navy. The minister of war employs it for the cordage of balloons, powder sacks, etc., and the Bank of France now uses nothing else for the manufacture of its notes but the ramie supplied by the Valobré factory. It has found the new bank note of ramie to be finer, more durable, and capable of receiving a better impression, and consequently rendering forgery of the notes much more difficult, if not impossible.

Consul Charles W. Whiley reports that the Bank of France has made a contract with the company by which the latter is obliged to keep in stock for the bank 20,000 kilograms of pulp in one of the bank's large storerooms at Marseilles, and to have on hand 20,000 kilograms more, while the bank itself has always a similar amount in its paper manufactory near Paris, making in all 60,000 kilograms at all times available. It is stated that the company is at present in negotiation with the Russian Government on the same subject, and already that Government has asked for a few thousand kilograms on trial.

It is here suggested that our own Government might also use ramie fiber to advantage in the production of its paper currency.

RAMIE CULTURE IN THE UNITED STATES.

Coming down to ramie culture in the United States, it has been previously stated in reports of this Department that the future of the ramie industry in America depends upon a careful consideration and understanding of the whole situation, studied connectedly—culture, stripping of the fiber, and the preparation of the fiber for manufacture. This does not mean desultory experiments in culture on limited areas, and without a full knowledge of the requirements of a perfect ramie stalk, but it does mean systematic endeavor based on a full knowledge of past experience in our own and other countries, and the cultivation of acres instead of rods square, not for one year, but for several years, keeping a strict account of all operations and of actual expenses and profits, that the presentation of mere calculated estimates may be avoided.

The conditions of successful growth must be understood. By successful growth is not meant the ability of the plant to shoot up stalks of requisite height, and to clothe these stalks with a healthy growth of leaves, but that such stalks shall contain proper spinnable fiber after having been grown, and in sufficient quantity per acre to yield an adequate return for the expenses of cultivation and the subsequent expenses of extracting the fiber and degumming it for the spinner. A stalk of

ramie either grows rapidly and rankly, when there is an excess of moisture, or it is stunted and of slow growth when opposite conditions prevail.

Where one of these conditions follows the other in the same growing crop, the fiber is adversely affected, for, in the after processes to fit it for spinning, treatment necessary to reduce the hard or stunted growth to the condition of spinnable fiber may wholly disintegrate the structure of the fiber in the softer or free-grown portion of the stalk, and great wastage and loss ensues. Or, the stalks in one part of the field may produce one grade of fiber and those on another portion a different grade; or the crops from two cuttings may differ in the same way. An acre of ground should produce 10 to 15 tons of stalks with leaves, say 12½ tons average, or 25 tons for two annual cuttings. French experiments have shown that every ton of stalks and leaves when properly treated will give about 25 pounds of the chemically degummed fiber fit for spinning, and the records of recent experiments in this country show about the same result.

It should be noted that this quantity of fiber means the product of a ton after the fiber has not only been cleaned upon the machine but has also passed through the subsequent processes to fit it for spinning. Another point to be noted is the difference in the cost of the fiber based upon the quality of ribbons turned out by the machine. According to the figures given by Landtsheer, mere stripped bark costs to treat about $65 more than China-grass, ton for ton of the degummed fiber, without considering differences of quality in the same grade of ribbons. It will readily be seen, therefore, that when the cultivation has been carelessly conducted, and the stalks are not only uneven in quality in themselves but uneven in different parts of the field (owing to different conditions of moisture, soil richness, etc.), that the loss in value may be sufficient to eat up the farmer's profits. This emphasizes the statement that the stalks should be grown freely and evenly during the season of their youth, and that they should be decorticated in such manner that they will approach as nearly as possible in appearance and quality to the China-grass of commerce. Too much water is as bad for a field of ramie as too little, and therefore it would seem that the best results will be reached where it is possible to employ some system of irrigation. And the application of fertilizers is also essential to successful growth.

A point not so well understood as it should be in this country is the importance of replanting at least once in four or five years to keep up vigorous growth.

CULTURAL EXPERIMENTS.

Mr. James Montgomery, who conducted a series of very valuable experiments, running over a considerable period of time, in the Kangra district of India, in speaking of the establishment of the field and its care during the first two years, writes as follows:

> After this the plants may well remain undisturbed for four years, hoeing well between after each crop, clearing away weeds, irrigating moderately during the dry season, and supplying manure where necessary. The only manure I had at command has been vegetable, consisting mainly of the leaves and wood portion of the plant itself, and of tree and vegetable leaves stored up for the purpose, with which I mix a considerable amount of wood ashes. With the aid of this only I have kept plants growing in the same spot for upwards of six years, but consequent on the then very crowded state of the ground the stems were short and very weak. I would, therefore, recommend a thorough removal after four years, the land to be then well plowed, cleaned, and manured.

In establishing this field the plants were set 4 feet apart each way. A Louisiana writer on this subject some years ago, but whose name is not appended to the brochure, accomplished the same result in another way, but he advocates that the rows be 5 feet apart and the plants 1 foot apart in the rows. He says:

If the roots are permitted to spread for two or three years they will form a solid bed from row to row, leaving no room for cultivation. This must be prevented by using a sharp rolling cutter on the plow, trimming the beds or ridges to a width of not over 18 inches or 2 feet. The method for doing this should be to cut or trim from one side only and allow the roots to spread on the other side. This would annually remove the old hard wood, keep the roots renewed and vigorous, and perpetuate the crops. The roots that are plowed out, if not required for planting, should be gathered and stored like sweet potatoes.

Setting out in rows is the only correct method of planting a field of ramie. Some have advocated the plowing up of a field of ramie when the roots became overcrowded, leveling off the ground and removing all exposed tubers, leaving the field to start up anew from the roots that remain buried in the soil. This is a shiftless method at best, as it is impossible under such conditions, to secure an even stand over the field, and an even growth of stalks is equally impossible. Mr. Favier, who has considered every phase of the ramie industry in France, from the preparation of the ground to the manufacture of the finished fiber into the most beautiful fabrics, gives the following rules for laying out a field:

The leveling being well established, there are traced furrows about 15 centimeters in depth and 20 centimeters wide, with a space of 70 centimeters* between. In these furrows the plants are placed upright against the slope of the furrow on the south side by preference, and 30 centimeters apart, alternating with the adjoining rows, and then they are covered so as to leave their tops level with the ground, or lightly covered to about one or two centimeters in depth, if there is fear of late frost. The earth which serves for covering is taken from the side of the furrow by scooping out the irrigating trench. We intend by this alternating to establish a plantation in the quincuncial form, each plant being placed opposite on an open space in the next line. The plantation is thus arranged in ridges, or "billows," and channels. A "billow" in agricultural parlance is a strip of earth raised between two trenches or channels.

Another system which also gives good results, if practiced with care, is the following:

Small projecting ridges are formed at a distance of 70 centimeters apart, and upon one side of these ridges, by means of a spike, there are formed holes 30 centimeters apart in which the plants are sunk to a level with the surface. In both these systems care must be taken to well heap up the earth around the plant, for if there are open places left about the root, the plant will not prosper. The lower extremity of the plant should be about on a level with the bottom of the irrigating trench, so that with the smallest quantity of water the moisture could easily reach the roots by infiltration and thus make sure of their growth. At the beginning of the plantation the channels should be as large as possible. Later when the plant has well taken root the ridges are allowed to extend and the trenches to become narrower so that the plants come to occupy the center of the ridge.

There is urgent need of further carefully conducted experiments with ramie in this country, under expert direction, in order to show the best results attainable, and to ascertain conclusively the cost of the varied operations and the value of the crop to the farmer. In this connection it is suggested that large appropriations in the hands of mere promoters, without experience and without practical knowledge of the requirements of the industry, or full appreciation of the obstacles that have hindered advancement, would be money worse than thrown away, for the failure can result only in an injury to the industry.

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*Equivalent to rows about 27 inches apart, with the plants nearly one foot apart in the row.

FLAX CULTURE FOR FIBER.

The beautiful display of American-grown flax and American-manufactured linen shown by the Department at the World's Columbian Exposition gave positive proof that the soil and climate of many portions of the United States are especially adapted to this culture. That the industry has not yet been established on a self-supporting basis is due to the fact that the conditions under which it must be established are not thoroughly understood, and that the obstacles to success have not yet been removed. To reduce it to a proposition, the special needs of the industry are a full knowledge on the part of our farmers of the practice required to produce good fiber, and labor saving machinery to place this practice, agriculturally, on a footing with other staple crops, in the production of which American farmers use the best agricultural machinery in the world. There is a third condition, the need of scutching mills to take the farmers' straw when grown and turn it into the kind of fiber that the manufacturer will purchase, but this is a question of capital, and when the other conditions are realized this matter will settle itself.

So much has been written in previous bulletins of the Office of Fiber Investigations regarding the proper practice for successful culture that it is hardly necessary to go over the ground in this report, although the suggestions will need to be repeated, again and again, before the necessity for following the practice outlined is fully appreciated. Seed culture and fiber culture are so distinctly different that the farmer who essays to grow fiber by the same methods he employs in growing seed can only make an ignominious failure, and he will do well to avoid the experiment. On the other hand, the Department has received many samples of flax straw grown from foreign seed according to its directions, and by men knowing practically nothing of fiber culture, which if retted and prepared would produce good fiber.

But will it pay? is the practical question. Not if the culture is conducted after the practice of foreign countries where flax culture is declining in many sections because of the primitive methods in vogue, together with high rentals for land, and the heavy expense of fertilizing, which make the production too costly.

The very cheapness of lands in this country and the fertility of the soil give us a positive advantage over many foreign flax-growers at the very outset. And with the establishment of what we have termed an "American practice," the varied operations of which are cheapened by the use of improved labor-saving machinery, there can be no question regarding the ability of the farmer to produce a crop of straw economically. For the preparation of the soil the ordinary implements found on every well regulated American farm will suffice, and there are none better in the world. The weeding can not be accomplished by machinery, neither will it pay for the farm laborer to go over the gound upon his knees, as is done in Belgium, but by eradicating the weeds from his soil by careful previous culture, and by planting only clean seed, the weeding will not be such a serious obstacle.

FLAX MACHINES.

The special classes of improved machines demanded by this industry, in establishing an American practice, are (1) a flax-pulling machine to do away with the laborious and costly hand pulling; (2) an economical thrasher, to save the seed without injury to the straw; and (3) an improved scutching machine to prepare the fiber for market.

Several machines in each class have been brought to notice, the latest inventions being a thrasher and a flax puller in California, and scutching machines in Michigan and Minnesota. The pulling is done by hand in foreign countries, but the American farmer will not pull flax, nor will the foreign farmer who emigrates to this country—and pulling rather than cutting is essential. Here again machinery must be brought to the farmer's aid, and a machine flax puller is not the mere possibility that it was even when these investigations were begun, but a palpable reality. Three or four machines to accomplish the work have been devised, one of which we examined in St. Paul two years ago. These are not yet perfect, but with experience, through practical demonstration in the field, and especially when there is an actual demand for such machines, they will be improved and perfected. A practical thrasher to remove the seed rapidly without breaking the straw is as much a disideratum. With the advent of a practical and rapid-working machine nearly every operation will then be conducted by horse power and the "American practice" will have been established. There is no doubt that the agitation of the question of flax culture in the past few years, if it had done nothing else toward making the industry a success, has stimulated invention in valuable lines, flax-thrashing machinery holding a prominent place.

As explained in a report of this office, the retting is not an agricultural operation at all, but should be conducted under the management of the scutch mill, for the scutcher alone is able to produce flax of a given standard from the straw grown on a dozen farms in his section.

From retting we come to scutching. An improved flax-scutching machine is a necessity; many machines have been invented for the purpose, especially in Europe, but while some of them have done fair work, they have not given sufficient satisfaction to come into general use. The latest of these machines brought to our notice recently is the flax-brake and scutcher invented by Alexander Morison, of Alpena, Mich., which, it is claimed, turns out 150 pounds of flax fiber in an hour from 600 pounds of straw. As we have seen only samples of the fiber, and have not witnessed the machine in operation, it is impossible to make authoritative statements concerning it.

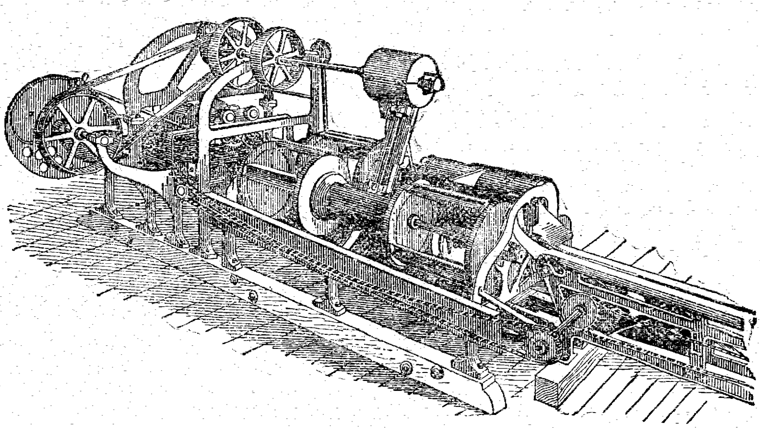

FIG. 1.—The Morison flax brake and scutcher.

The machine is a combination of two patents, the first and original patent dated November 10, 1891, and the other patent dated December 26, 1893, using the brake of the one patented in 1893 and the scutcher

of the one patented in 1891. In the construction of machine there is a table where the straw is spread in a thin layer, crosswise, and in this table a pair of endless chains carry the straw forward in front of the brake.

The straw is broken and crushed upon a fluted brake table with the flutes running lengthwise. When the straw comes up in front of the brake it lies crosswise of these flutes, and before coming quite up to the brake is pressed close on the flutes by several springs arranged so as to let the straw pass under the brake roller without bunching in front of it. The straw is carried over this fluted table by six endless chains; two long ones that carry it off the spreading table, and four short ones that run only the length of the fluted table. The fluted roller does the breaking. The flutes of this roller intermesh in the flutes of the fluted table. This roller moves backward and forward from side to side of the fluted table, and as the straw is carried in sidewise under the roller in its full length by the endless chain it is crushed and broken. After the broken straw has left the roller, and before it leaves the end of the fluted table, it is picked up in the center by a thin endless chain with slim, sharp-pointed teeth, which come up through the fiber, and as the chain moves toward the rear end of the machine the fiber is carried under a grooved pressure bar that presses and holds the fiber firmly in the teeth of the endless chain. As the fiber passes through between the first pair of revolving scutches it whips and combs the fiber downwards, and as it passes between the second pair it scutches and combs it upwards.

The inventor states that the machine is operated by one man and two boys; 7,500 pounds of straw is claimed as the record for a ten hours' run, and of long fiber saved, with the tow nearly all taken out, 1,500 pounds.

Mr. Eugene Bosse, of St. Paul Park, Michigan, has recently invented a scutching machine, but we have seen neither a description of the principle involved in the construction nor specimens of its work.

Among recent foreign inventions may be mentioned an improved flax-breaking machine invented by Arthur Spiegelberg, a flax merchant of Dundee, Scotland. Its manufacturers make statements as follows:

> The machine has been designed with the object of preserving and saving the fiber, and the results obtained demonstrate how successfully this is accomplished. It deals with the flax straw in a manner closely resembling the action one applies by hand to small portions of straw, to see, for instance, if it be well retted. The manufacturers state that the straw is fed into the machine as in an ordinary breaker, and leaves it in the form of a ribbon, and in a state to be sent direct to the hackle without the necessity of scutching. It effectually breaks and detaches the "shive" from the fiber, and thus proves its marked superiority over any existing system. The results attained have exceeded the most sanguine expectations of the inventor. A small parcel of Livonian flax straw treated on the premises of an Arbroath spinner yielded 25 per cent of line, or practically as much line as can be produced by other systems in scutched flax. The machine is easily worked (1 to 2 horse power), and is able to treat about 12 cwt. of straw per day. Every precaution has been taken to test the practical efficiency of the machine before putting it before the public. The makers are Messrs. Samuel Lawson & Sons, Leeds.

FLAX CULTURAL EXPERIMENTS.

It is interesting to note that among the many samples of flax straw shown at the Columbian Exhibition was one grown in Colorado by a farmer of that State whose experience had been limited to culture for seed. His product was found to be so excellent that the committee unhesitatingly gave it an award, its special merits being length of straw and tenacity of fiber, showing generally good cultivation. Flax-grow-

ing with irrigation should be the subject of special experiment under expert direction, as irrigation at the proper season would doubtless do away with the chief causes of the few failures that were recorded in the Department experiments in 1891, viz, drought on the one hand, at the time when the crop should have had the needed moisture, and overplus of moisture on the other hand through heavy rainfall, before the plants had established themselves, annoyances which the farmers in irrigation districts do not fear.

A small flax experiment was conducted under Department auspices in the State of Washington during the season of 1893 by Dr. A. W. Thornton, of West Ferndale, assisted by a number of farmers of the Puget Sound region. The immediate results of this experiment are very interesting; the samples of straw submitted are fine, long, and even, with a thin, brittle straw, the shive separating from the fibrous portion of the stalk readily even in an unretted condition. The straw produced in this experiment should be retted and the fiber prepared, and we have no hesitancy in saying that, if the work is properly done, as far as possible after the manner of retting followed in the Lys district of Belgium, a high-grade flax will result. A more comprehensive experiment is recommended for the present season, as flax culture can doubtless be made a profitable industry in this region.

Experiments of the Department in 1891-'92, both in Washington and Oregon, have demonstrated that the far Northwest is especially adapted to the growing of high-grade flax. Samples of straw received from Oregon in 1891 were of superior quality, and with proper preparation would have produced a fiber approaching in strength and fineness to the best European flaxes.

The fine samples of linen crash manufactured in the United States, from home-grown flax, and exhibited in the Department's fiber collection at the World's Fair in Chicago, prove that we can manufacture flax. The largest display was of bleached and unbleached crash in bolts and draped fabric, manufactured at the Stevens Linen Mills, Webster, Mass., from flax grown and prepared in Minnesota by Mr. Eugene Bosse. A second display of fine crash and towels with borders was received from the Sioux Falls Linen Mills, South Dakota, made from flax grown and prepared in that State.

THE GROWTH OF FLAX FOR EXPORT.

During the year several letters have been received from Europe making inquiry concerning flax for export, soliciting samples, and asking for the addresses of those who might be able to supply a foreign demand. At the same time the United States consul-general of Germany has recently presented a report, with interesting statements concerning the imports of flax into that country, in which the possibility of exporting American flax fiber to Germany is seriously considered.

The possibility of developing an export trade in flax with foreign countries has been dilated upon in former reports issued from the Office of Fiber Investigations, and the fact of a steadily declining home supply in foreign flax-growing countries has been pointed out. That foreign flax spinners are looking to this country as a future source of supply emphasizes the importance of growing flax for fiber in the United States, where in so many sections the conditions are advantageous.

The consul-general at Frankfort states that during the year 1892 Germany imported over 60,000 tons of raw flax fiber, which was utilized by thirteen large spinneries. Over 55,000 tons came from Russia,

which country, it seems, also exports largely to England and Belgium, indicating a demand for the raw fiber in these countries. Germany admits this product free of duty; and owing to the differences on the question of the tariff existing between Germany and Russia, the consul pertinently suggests the possibility of the flaxseed-growers of the United States, who now throw away immense quantities of the straw, utilizing it by taking the trouble necessary to save and prepare it for export. It is urged as more than probable that in certain sections of this country, and at the expense of a little time and trouble, the flax straw now wasted may be so saved as to compete with the Russian flax straw in the markets of Germany, England, and Belgium.

It is a mistake to consider that utilization of the now wasted straw from fields where flax is grown for seed will supply this demand. The straw from a field of flax grown for seed is coarse and woody, and, as a rule, is deficient in fiber. By adopting a mean in our practice between the two extremes of culture flax grown for seed alone and flax sown thickly for fine fiber, we will be able to grow both seed and fiber, and the latter will be of a quality as good as much of the flax that is exported from Russia. The larger part of the straw from seed cultivation, as now practiced in this country, would not give a quality of flax that the German spinners would buy at any price, and it is doubtful if it would pay to work it on account of the straw being so coarse and short and so deficient in fiber. Our farmers can improve their product, however, with a very little extra labor and expense, and produce a lint that can be utilized in manufacture and at the same time they can save their seed. This matter has been fully discussed in former reports ssued from this office (Fiber Reports Nos. 1 and 4), to which the reader is referred for details of the special practice required.

PINEAPPLE FIBER.

In the report last year there was a short chapter with an account of experiments in Florida, made to determine the yield of this fiber to the ton of leaves, and to ascertain whether the quality of the fiber was sufficiently good for utilization commercially if it could be extracted economically. The fact that the pineapple is cultivated for its fruit over a large area of southern Florida, and that the leaves are allowed to go to waste after the fruit has been cut, makes possible in Florida a new industry that may add considerable to the resources of the State.

Experiments with the fiber were only preliminary, but as far as they went were most satisfactory. The fiber yields readily to machine manipulation and comes out white and clean without washing by simply drying in the sun after being extracted. The desideratum is an economical means of extracting the fiber, and as there are over 20,000 leaves to the ton it will be seen at the outset that the economical machine will be one that takes quite a quantity of leaves at a feeding. The machine used by the Department at Cocoanut Grove was inadequate from the commercial standpoint, as only a few leaves could be extracted at one feeding. It produced almost perfect fiber, however, and enabled us to attain the object of the investigation, viz, the determination of quality and yield, although without regard to cost of production.

MACHINES FOR EXTRACTING THE FIBER.

Recently the attention of pineapple-growers and others has been called to the possible importance of the new industry and a large cor-

respondence has resulted. Further experiments are needed to settle the question of economical extraction of the fiber. The sisal hemp machines will accomplish the result in a manner, but the leaves differ so greatly in structure and size from the leaves of the fleshy agaves that the sisal machines would be found too rough and, it is thought, would injure the fiber. Possibly some modification of the machines described in Fiber Report No 3, on sisal hemp culture, and in Fiber Report No. 5, on the leaf fibers, would answer the purpose. It would need to be a smaller machine, specially constructed to manipulate the more delicate fiber found in the leaf of the pineapple plant without injuring or breaking it, which would necessitate great waste. An improvement on the Van Buren machine that would permit of continuous action without the withdrawal and reversal of the leaves in order to clean the ends held in the hand, might accomplish the result, or the construction of a modified machine embodying the best principles of the T. Albee Smith and J. C. Todd sisal hemp machines would, it is thought, produce a valuable decorticating device. Mr. W. T. Forbes, who has experimented with samples of fiber sent from the Department, informs us that the fiber will not stand the high degree of heat of a digester, and a "process" depending in part upon heat would not be satisfactory, as the fiber might be weakened. Experiments will be made, however, upon green leaves to further test this matter.

Undoubtedly there will be a great future for this industry if the fiber can be extracted economically. In a ton of pineapple leaves there is double the weight of fiber that is in a ton of green ramie stalks, with the added advantage that when the fiber has left the machine and has been dried it is ready for market without having to be degummed. It is true that the fiber is less valuable than ramie, but, on the other hand, it could be utilized in many products where more valuable fibers are employed, and doubtless new uses would be discovered.

We know that certain forms of pineapple fiber have been utilized in eastern countries in the fabrication of most beautiful tissues, poetically referred to as "the woven wind of India's looms." Among the possible uses of the Florida fiber may be mentioned fine twines similar to "flax threads," yarn to be used in the backing of carpets, the coarser fabrics, and even tapestries and upholstery goods. And it has been suggested that it could be used as the warp in silk textures and for the finish for furniture coverings, etc., with the advantage that it would be moth proof. Dr. Thos. Taylor has subdivided Florida pineapple fiber to the one-ten thousandth of an inch. In recent tests of strength it was found that a fiber twisted to the size of binding twine stood an average strain of 150 pounds.

It is most important that the machine question, as it relates to the economical extraction of the fiber, should be settled, when capital will undoubtedly come to the aid of the pineapple-growers and make a success of the new industry.

PALMETTO FIBER INDUSTRIES.

Among the vegetable fibers imported into the United States is a coarse upholstery material known commercially as Crin végétal, or African fiber, 900 tons of which were imported last year. The fiber is produced from the leaves of the *Chamærops humilis*, a species of palmetto closely allied to the saw or scrub palmetto of Florida and the Southern States, the supply of which is almost inexhaustible. The

leaves can be shredded by simple machinery, and if the operation could be performed in this country at an economical cost to admit of competition with the foreign article the preparation of the fiber could be made a large industry. The saw palmetto should become a valuable fiber plant, as there is no part of the plant that is not available for some purpose. The fresh roots, which are 3 to 5 inches in diameter, are made into cheap brushes. They are sawed into discs an inch or more in thickness, the pulp scraped out to the depth of two-thirds of an inch by means of toothed scraping wheels, when the longitudinal fibers thus exposed form the bristles of the brush, the untouched portion of the disc forming the back. This takes a fine polish, and when the sides are shaped and polished the brush is completed.

USES OF PALMETTO LEAF STEMS, ROOTS, ETC.

The leaf stems are used to some extent as a coarse fiber material. The Loomis Manufacturing Company, at Fernandina, Fla., produces from these stems a substitute for cow's hair in plastering, which is not only cheap but very durable. The stiffer fiber, when combed out, is capable of use in the manufacture of whisk brooms, though the filaments are somewhat brittle. A coarse cordage might also be made from the fiber, but it would lack in softness and strength compared with the commercial fibers. The leaves, as stated, can be shredded to make a good upholstery material, and they also form a most valuable paper stock.

Both roots and leaves of the palmetto contain a large percentage of tannin, and the extraction of the tannin from palmetto leaves has already become an industry. Mr. C. B. Warrand, of Savannah, Ga., has recently sent to the Department samples of leather tanned with this product in twelve days, and claims that this leather can be more economically produced than the leather tanned with oak or hemlock bark. The residue forms a valuable paper stock, which is also utilized. Regarding the process of extraction, Mr. Warrand informs us that the leaves and stems are separated, the stems are crushed flat through rollers, but the leaves are finely shredded; this material is then placed in a large wooden tank and covered with water, and the mass is brought to the boiling point, but is not allowed to boil violently; it is kept near, but below, the boiling point for forty-eight hours; the liquid is then ready for the tannery. After the tannin has been extracted the palmetto is steamed in a chemical solution, which removes the silicate contained in the palmetto and changes the glossy shield to a gummy mass, which can be removed without injury to the fiber. In making imitation horsehair this gummy mass is allowed to dry, as it adds to the elasticity of the fiber. There are several combinations in which the production of tannin and fiber can be advantageously operated. Tanneries situated in the vicinity of paper mills can grind the palmetto in the same manner as bark; the residue, after bleaching, is in the proper shape for the paper mill. In this way palmetto can be profitably shipped and used at long distances.

Showing the cheapness of the supply of raw material, which is practically inexhaustible and which rapidly reproduces itself, it is stated that the cost of cutting and gathering the palmetto will not exceed $2 per ton; hauling and baling will cost about $1 per ton, and if fifty cents be paid for stumpage to the land-owner it is claimed that palmetto ought to be delivered at the cars from $3 to $4 per ton, f. o. b.

The cabbage palmetto is used to a considerable extent as a brush-

fiber material, the "boots," or spathes of the leaf stems, which surround the "bud" being used as the raw material. The Florida Fiber Company, of Jacksonville, has been manufacturing this brush fiber for several years. The prepared fiber is reddish in color and when polished and oiled forms a handsome brush material. After combing out the straight fiber, there is about 70 per cent of tangled, softer fiber, which resembles coir. We are not able to state that this is manufactured, though it is capable of employment in several uses.

The selected leaves of the cabbage palmetto are capable of manufacture into hats for summer wear, of great beauty and finish. In the bazaars of Florida cities that are winter resorts, ladies' hats made of this material are regularly sold, and men's hats are also made from this species.

THE INDIGENOUS BAST FIBERS.

There are probably a dozen species of indigenous plants in the United States capable of producing a fair quality of fiber that grades a little higher than jute, two or three species of which produce fiber almost as good as hemp. Specimens of the plants and small samples of the rough stripped fiber are frequently submitted to the Department by those who desire information regarding the possible commercial value of these fibers, and suggestions as to cultivation. Some of these have already been experimented with in a small way, such as the *Abutilon avicennæ*, *Asclepias incarnata*, *Urtica gracilis*, *Urena lobata*, and the several species of mallows which belong to the genus *Hibiscus*.

In regions where flax and hemp can be readily grown, these species, doubtless, will never be cultivated for their fiber; but there are localities where such fiber industries, even should they never reach large proportions, would benefit the community in which the enterprises were located. As they are matters of constant inquiry, letters coming from every section of the country, the facts regarding the different species have been collated for publication and will form Report No. 6 of the Fiber Investigation series. A considerable amount of valuable information has been accumulated on the subject. A full series of both stalk and fiber of the different species was exhibited at Chicago.

REPORT OF SPECIAL AGENT AND ENGINEER FOR ROAD INQUIRY.

SIR: Inasmuch as the operations of the Office of Road Inquiry have but fairly begun, it may be useful to present a statement of its plans and purposes as formulated or approved by you, and of the preliminary work already done in accordance therewith. I have the honor, therefore, to submit the following report.

Very respectfully,

ROY STONE,
Special Agent and Engineer for Road Inquiry.

Hon. J. STERLING MORTON,
Secretary.

PLANS AND PURPOSES OF THE INQUIRY.

The work of this office was begun in pursuance of the following appropriation made by the Fifty-second Congress:

To enable the Secretary of Agriculture to make inquiries in regard to the systems of road management throughout the United States, to make investigations in regard to the best method of road-making, to prepare publications on this subject suitable for distribution, and to enable him to assist the agricultural colleges and experiment stations in disseminating information on this subject, ten thousand dollars ($10,000).

Upon my appointment as special agent and engineer, I received the subjoined letter of instructions:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., October 3, 1893.

SIR: You have been this day appointed to supervise and carry out the investigation pursuant to the statute approved March 3, 1893, which has four branches:

(1) To make inquiries in regard to the systems of road management throughout the United States.

(2) To make investigations in regard to the best method of road-making.

(3) To prepare didactic publications on this subject, suitable for publication.

(4) To assist the agricultural colleges and experiment stations in disseminating information on this subject.

It will not be profitable to enter upon all these points at first. The work under the appropriation will need to be of gradual growth, conducted at all times economically. Therefore it is not expected that there will be any considerable force of clerical help, and, aside from your salary, no considerable expenditure for the present. It is understood that you have at your command the data for a compilation of the laws of several of the States upon which their road systems are based. It should be your first duty, therefore, to make such collection complete, and prepare a bulletin on that subject.

Incidentally, while preparing this bulletin, you should charge yourself with collecting data relating to different methods of road-making, which, in the first instance, should be generic in their character; including—

(1) The best method of constructing a common highway without gravel or stone.

(2) Gravel highways.
(3) Macadam and other stone roads.
(4) Data upon which to base suggestions for the transportation of material within reasonable access, for the proper surfacing of the roadbed. These data should form the foundation for the second bulletin, or second series of bulletins.

There are certain restrictions I wish specifically to bring to your attention. It must be borne in mind that the actual expense in the construction of these highways is to be borne by the localities and States in which they lie. Moreover, it is not the province of this Department to seek to control or influence said action except in so far as advice and wise suggestions shall contribute towards it. This Department is to form no part of any plan, scheme, or organization, or to be a party to it in any way, which has for its object the concerted effort to secure and furnish labor to unemployed persons, or to convicts. These are matters to be carried on by States, localities, or charities. The Department is to furnish information, not to direct and formulate any system of organization, however efficient or desirable it may be. Any such effort on its part would soon make it subject to hostile criticism. You will publish this letter in the preface to your first bulletin.

Yours truly,

J. STERLING MORTON,
Secretary.

Mr. ROY STONE,
Special Agent and Civil Engineer,
Good Roads Investigation.

PRELIMINARY WORK.

Upon receipt of these instructions, letters of inquiry were prepared and sent—

(1) To the governors of all the States and Territories, as follows:

The Congress of the United States having made provision [here follows the appropriation as above], I have the honor to request your excellency's aid and coöperation in inaugurating this important inquiry.

The information regarding foreign roads and road-making gathered by the Department of State through its consular representatives has proved to be of great value, and a corresponding home inquiry should be even more profitable. So many States and communities are attempting road improvement, and so many others are considering it, that a definite knowledge of what each has proposed or accomplished might be invaluable to many of the others. Such knowledge can be practically reached and disseminated only through a central agency, but that agency will need the assistance of all the State and local officials concerned in order to bring its work within the means allotted by Congress and within a proper limit of time.

The officer in charge of the inquiry has therefore been instructed to communicate with the secretaries of state of the several States on the subject, and the Department would respectfully ask your excellency, if it meets with your approval, to give your sanction to his requests, together with such voluntary aid as it may be in your power to give or procure, and will be further indebted to you for any recommendations or suggestions regarding sources of information or the scope of the inquiry itself, which is as yet somewhat undefined.

(2) To the secretaries of state, as follows:

The act of Congress making appropriations for this Department for the current fiscal year contains the following provisions:

"To enable" [etc., as before].

The scope of this inquiry corresponds closely with that of the one successfully made by the State Department, through its consular representatives, into the road laws and methods of road construction in foreign countries.

The success and value of a home inquiry will depend much upon the aid given it by the various State and local officials who have been concerned in road improvement. I have the honor, therefore, to request your coöperation in this important work, to the extent at least of furnishing the names of all such officials and of any individuals who may in your judgment be able to give valuable information or suggestions pertaining to the subject.

I take leave also to ask for copies of all recent laws or compilations of laws bearing upon roads and highways.

As the inquiry progresses the Department will furnish you with copies of all published results.

(3) To Members of Congress, as follows:

In pursuing the inquiry into "systems of road management" and "methods of road-making," authorized by the Fifty-second Congress, the U. S. Department of Agriculture desires to communicate on the subject with the best informed authorities and private individuals throughout the United States, and, to expedite the matter, I have the honor to request your aid in procuring the names of all counties or townships in your State which have made a systematic attempt at modern road improvement, and also the names and addresses of the officials and of some of the individuals most actively concerned in such improvement, whether in respect to legislation or road construction.

If you are personally interested in the subject I shall be glad to receive any further information or suggestions from you pertaining to the inquiry.

(4) To the State geologists, as follows:

The U. S. Department of Agriculture has been assured of the general and hearty coöperation of the State governments in the inquiry authorized by Congress "into the systems of road management and the best methods of road construction throughout the United States;" and as one of the most important branches of the inquiry relates to road materials and thereby comes within your province, I take leave to ask for such information on that head as you may be able to give—having in view the supply not only of your own but of adjacent States—if you have material of superior quality. The general use of the highest class of materials involves the cost of railway transportation for most of them, but the Department is already assured by many of the railway companies of their disposition to accord extremely low rates on such traffic for the encouragement of road-building, and if this action becomes general a haul of 100 or even 200 miles may not be prohibitory, so that the very best roads may be built in regions which have no local supply of material.

I send herewith the general circular of inquiry, and shall be glad to receive any information you may be able to give or obtain on other branches of the subject.

(5) To railroad presidents, as follows:

The U. S. Department of Agriculture has been authorized by Congress to make inquiry into the systems of road management throughout the United States and the best methods of road-making, and to collect and distribute information regarding the same.

The interest uniformly shown by railway managers in the improvement of highways warrants the Department, which has been charged with this inquiry, in asking their assistance. The undersigned, therefore, respectfully requests: (1) Information (which can doubtless be gained through your engineering department) regarding the supply of good road material along or near your lines—their location, character, accessibility, and the cost of preparation and loading on cars; (2) your schedule rates for transportation of the same; (3) a statement of any reduced rates or free transportation that may have been granted or offered in special cases to encourage road-building; (4) any information, recommendations, or suggestions from yourself or any of your staff that may promote the success of this inquiry or the general interest of road improvement.

(6) General circular of inquiry, as follows:

The U. S. Department of Agriculture, being charged by Congress with an inquiry into the systems of road management and the best methods of road construction throughout the United States, desires information upon the following points:

(1) The practical working of the recent road laws of the various States wherever the same have been tested, the difficulties found in their application, and suggestions for their amendment.

(2) The character and cost of the roads built under these laws, the materials used, and the present condition and prospective durability of such roads.

(3) The location and character of any superior stone for roads which is accessible by railway or water, the cost of quarrying, preparing, and loading the same, the mileage rates of transportation, and any instances of reduced or free transportation given by railways for the encouragement of road-building.

(4) The same information, so far as applicable, regarding materials naturally prepared, such as the Paducah and Tishomingo gravels, the Hamilton sandstones, and the Chickamauga flints.

(5) The results of any experiments in the construction of narrow and cheap hard roads, or of roads having one track of earth and one of stone or gravel, with full particulars as to cost and method of construction.

(6) The result of any practical experience in the use of burnt clay for roads.

(7) The cost and benefits of tile drainage of roads as shown by practice.

(8) The best method of constructing a common highway without gravel or stone, and with or without underdrainage.

(9) Definite facts as to the enhancement of property values through road improvement.

(10) The results of any experiments in the employment of convict labor on roads or the preparation of road materials.

(11) The details of all bond issues for road improvement, and how, where, and at what cost the bonds were marketed.

(12) The rates allowed in each State for men and teams in working out road taxes, and the actual value of such work as compared with labor paid for in cash.

CHARACTER OF THE INFORMATION COLLECTED.

The responses of the governors and secretaries of state have been most hearty and cordial, giving evidence of the warmest interest in the work and promises of all the assistance in their power.

Many Members of Congress have responded in like manner. The State geologists are beginning to supply the information asked of them. Fifty railroad companies have already sent in reports of their engineers or other officers, many of them very complete and satisfactory. This information is being tabulated, and when it is all received, with that from the geologists, it will be possible to make a map showing the location and cost of the best road materials throughout the United States.

The office of the United States Geological Survey is rendering valuable assistance, and it could be of the greatest service in the general inquiry if its means permitted.

Nearly all of the railroad companies show a willingness to promote the improvement of highways by cheap transportation of materials, and since in any general system of improvement railway transportation will be almost universally required, if the best materials are to be used, this is one of the most encouraging features of the situation.

RECENT STATE HIGHWAY LEGISLATION.

The first bulletin of this office is now in the hands of the printer, and is composed of a brief of the new road laws of 14 States, with full extracts of the essential portions of the same, and some recommendations made by influential public bodies but not yet carried into legislation.

The advance in road legislation proceeds on several distinct lines:

(1) In the direction of more rigid provisions for carrying out the old systems without radical change of the systems themselves.

(2) More liberal tax levies.

(3) Substitution of money taxes in place of labor.

(4) Local assessment, according to benefits, for construction of new roads.

(5) Construction by townships, with power to issue bonds.

(6) Construction by counties.

(7) State highway commissions.

(8) Provision for working convicts.

(9) Direct State aid to road-building.

(10) Building of State roads.

CHARACTERISTIC FEATURES OF CERTAIN STATE LAWS.

The new road law of Tennessee (1891) is an admirable example of the first of these classes. By giving to the county court full power and direct control over the whole subject of roads, it ought to eliminate

the evil influences of local politics and the easy-going methods that generally prevail. The court classifies the roads, establishes the districts, and appoints the commissioners; each commissioner divides his district into sections and appoints the overseers. The commissioners have full control of the roads and bridges and can remove the overseers at pleasure. The court assesses the road tax, within a limit of eight days' work for each male inhabitant between 18 and 45 years of age, and of 25 cents per $100 of property. The overseers may dismiss any man whose work is unsatisfactory and proceed against him by suit as in case of refusal to work or failure to pay the property tax. Damages in such cases are collectable out of any property, except the homestead, or out of wages.

The overseer on his part is liable to be sued by any citizen for neglect of duty and to be fined $20 therefor, and commissioners for the same offense are liable to be indicted and fined $50. Such fines to go to the road fund.

In the direction of increased tax levies, Vermont, New Hampshire, North Dakota, and Oregon are conspicuous, the last-named State allowing the county courts to levy a special tax of 50 cents on the $100 and $2 per head for a county road fund.

The abolition of labor taxes is absolute in New Jersey and also in Wisconsin, excepting in those towns which specifically vote to retain it. It is absolute in those counties of New York whose board of supervisors adopt the county system, and optional with all the towns in New York by affirmative vote at town meeting, many having already availed themselves of this privilege.

Construction on the local assessment plan, extending to a limit of 3 miles on each side of the line of road, obtains to some extent in Oregon, Indiana, and by special acts in Ohio. In Oregon the county may assume 50 per cent of the cost, and in Ohio a larger share is usually placed on the county list by the act.

Construction by townships has been quite extensive, and in Pennsylvania and New Jersey township bonds have been largely and successfully used.

The county system, however, is the special feature of recent legislation, many of the new States having started out with it in some form and many of the older ones having adopted or seriously considered it. The issue of county bonds is provided for in New York, New Jersey, Indiana, Michigan, and Washington, but in the last two a popular vote is requisite to authorize the issue, and in Indiana the term of payment is limited to five years.

State highway commissions have been constituted in Massachusetts, Vermont, Pennsylvania, Ohio, Michigan, and possibly in other States; these are generally temporary bodies charged only to inquire and recommend, but in Massachusetts the commission is permanent and has important duties connected with actual road improvement.

In the working of convicts on roads New York is making an experiment near Clinton Prison with State prisoners, and Tennessee makes all persons confined in county jails or workhouses available for highway labor.

New Jersey is probably the only State giving direct aid to road-building. Such aid is limited to one-third of the cost of roads built by the counties and to the sum of $75,000 per annum.

The highway commission of Pennsylvania has reported a bill for State aid to the amount of $1,000,000 per annum, to be distributed among the townships in proportion to the road tax paid by them, on

condition that they set aside 25 per cent of their tax for making permanent highways.

Building of State roads has been done in some western States, and Washington is now building a road through the Cascade Mountains under charge of a special commission.

The Massachusetts highway commission has authority to adopt any road as a State highway, to be constructed and maintained as such if the legislature makes appropriation therefor.

Coöperative road-building, as provided for in New Jersey, has been very successful, abutting land-owners paying one-tenth of the cost, the State one-third, and the county, by sale of bonds, the remainder. Under this law 10 miles of road were built in 1892, 25 in 1893, and 64 are applied for by land-owners for 1894.

NEW ROAD CONSTRUCTION.

REDUCED COST OF ROAD-BUILDING.

Information on this head is meager as yet, but enough has been gained to show that new construction is proceeding in many parts of the country, and that, as might be expected, increased knowledge and skill, improved machinery and methods, and extended practical experience are rapidly lessening the cost of good roads.

Mr. E. G. Harrison, civil engineer, of Asbury Park, N. J., under whose supervision permanent roads have been constructed in that State, says: "Three or four years ago the cost of road-building was $10,000 per mile. Last year I built roads for $3,500 per mile; the stone was brought by rail at a cost of $1 per ton for transportation." Maj. M. H. Crump, of Bowling Green, Ky., who has built many miles of the excellent highways in that State, says a good telford road can be built for $2,000 per mile, including grading. J. B. Hunnicutt, professor of agriculture in the University of Georgia, states the cost of good hard roads recently built in that State, giving one track of stone and one of earth, at $1,200 per mile. H. G. Chapin, supervisor, of Canandaigua, N. Y., recently reports the building in that town of 10 miles of single track stone road with an earth track on each side for $900 per mile, the crushed stone being laid 1 foot deep and 8 feet wide. In this case the township owns a movable crusher and prepares its own material, the neighboring farmers delivering field stones at the crusher for 20 cents per load.

BENEFITS OF ROAD IMPROVEMENT.

Information in this regard is more abundant. A few well-authenticated cases are selected.

Hon. Edward Burrough, president of the State board of agriculture of New Jersey, says that on the new stone road from Merchantville to Camden his teams haul 85 to 100 baskets of potatoes, where they formerly hauled only 25. Mr. Burrough says further that "one of our counties has issued $450,000 of 4 per cent bonds and put down 60 miles of stone roads, averaging 16 feet wide, and though they pay the taxes to meet the interest on these bonds, their tax rate is now lower than it was before the roads were built."

Mr. Chapin, heretofore quoted, says of the Canandaigua roads that they are as good in March as in July; that they have increased the value of the adjoining farms many times the cost of the roads, and

that the cost of keeping them in good repair is much less than that of keeping poor roads in poor repair. Mr. Garfield, speaking at the Michigan engineers' convention in 1893, says that in his township, while farms have generally been declining in value, the building of a gravel road 4 miles in length has increased the value of those adjoining it 52 to 40 per cent, and this not a free, but a toll, road.

The owner of a large tobacco plantation some miles from Henderson, Ky., having great difficulty in moving his product to market in that city, organized a company and built a toll road. He estimates the increase in the value of his property at threefold, while the road has paid annually over 10 per cent in dividends.

Additional evidence from farmers in New Jersey is given below.

From H. Darnell, Mount Laurel, N. J.:

In reply to your letter asking the views or opinions of farmers as to the efforts now being made regarding the permanent improvement of public roads, I would say that since having some of them so improved among us it is the universal opinion among farmers that they are of more benefit to the agricultural community than anything that has ever been done for them, and that they will derive more benefit therefrom, considering amount of cost, than from anything that has been heretofore accomplished.

From Samuel L. Allen, Philadelphia, Pa.:

The assistance of the State in building permanent stone roads in the vicinity of my farm and home, in Cinnaminson township, Burlington County, N. J., has been very beneficial and thoroughly appreciated by myself and many other farmers. At first the farmers of the neighborhood were largely opposed to the movement; but within the past year they have become almost unanimous in favor of the extension of the system. I am hoping that the State appropriation may be largely increased.

From H. H. Brown, Old Bridge, N. J.:

We have four miles of macadam road through our township. Property has almost doubled in value and travel has more than doubled. Farmers carting over our road speak in the highest terms of it. It is a rest for their horses to cart over it. Our citizens are greatly in favor of having it extended and I think the law as it is, is working very nicely all over our county and I would be very sorry to see it changed.

From Clayton Conrow, Cinnaminson, N. J.:

While I believe that good roads are of great benefit to all the mercantile, manufacturing, and agricultural industries of our State, they have enabled the farming class of our citizens especially to conduct their business at a profit by reducing the cost of fertilizers brought on to the farm and the expenses of conveying products to the market. In fact, this apparently small item of expense, daily saved, constitutes the difference between success and failure. Good roads enable the farmer to place his products on the market when at the highest point; bad roads often forbid this. Good roads enable him to deliver perishable vegetables and tender fruit in so much better condition that they invite the better class of customers and command a higher price. Thus every consideration of the subject, if carried to its legitimate conclusion, is in favor of good roads. We can't afford bad roads. Their effect is enervating, while that of good roads is inspiring.

From Dennis Long, Union, N. J.:

I think the law granting State aid in the building of stone roads is one of the best that can be put on our statute books, and that the sooner our public roads are all in the hands of the freeholders of the different counties, with some competent men to supervise and construct the same in a permanent way with stone for a solid foundation, well pounded and wedged, and with broken stone on top solidly rolled, the better off the people of New Jersey will be.

We have a county road in my own neighborhood, of which we are very proud, and near which property has advanced 50 per cent of its value before the road was laid. A case in point is that of a piece of property along this county road, which could have been bought for $20,000 before the road was built, and only a few days ago the owner was offered $30,000 for the same farm, and it is two miles away from any railroad station. And there are many more cases of the same sort.

From Wm. R. Lippincott, Fellowship, N. J:

In reference to the farmers' views on building stone roads in our State, it is safe to say that the general impression among farmers is that stone roads improve the country they pass through. Where they have been built one can already see greater energy being manifested among the farmers along their lines. One of the most important things for the farmer is easy access to a market where he can sell his products, and stone roads are to agriculture what rivers are to commerce.

Again, goods roads show the most direct benefit to the farmer for the taxes he pays, and in many instances save him in toll a heavy interest on their cost. Almost every intelligent farmer views stone roads as forerunners of other improvements that must follow, such as the electric railways, free mail delivery, and an increased demand for country residences, and the numerous applications presented to the boards of freeholders speak in plain language the farmers' views on road improvement in New Jersey. I hope the governor will not approve any bill that tends to stop this great onward movement for good roads.

From Stockton Hough, Trenton, N. J.

In answer to your inquiry concerning the benefits derived under the law granting State aid in building stone roads, I would say from my experience as the first promoter of these roads built in Mercer County, N. J., that in the beginning I met with opposition at every step; and now that the road is near completion, all opposition has been silenced, and all are anxious to extend the system wherever possible. This sentiment is growing daily with the experience of those who use these roads, many of whom never had any opportunity to know what a good road is. Travel has already doubled over our road, and property has greatly increased in value. Building sites are being laid out, and improvements are projected even before the road is completed. As the owner of two farms and a mill property on this road, I am confident that they will be greatly increased in value. At times in the winter we could not haul one-half a ton with a team from any of these properties. Now with the road completed, 2 tons is less of a load than the empty wagon on the old road at times in the winter and spring. I am of the opinion that the improvements would be cheap at five times the cost.

REPORT OF THE SPECIAL AGENT IN CHARGE OF IRRIGATION INQUIRY.

SIR: I have the honor to submit herewith the third annual report of the Office of Irrigation Inquiry, for the calendar year 1893.

Very respectfully,

CHARLES W. IRISH,
Special Agent in Charge.

Hon. J. STERLING MORTON,
Secretary.

The present incumbent assumed the duties of Special Agent in Charge of the Office of Irrigation Inquiry on the 1st of June, 1893. The only material then on hand relating to the work of the office was the manuscript of an "Abstract of the Laws of the several States and Territories on Irrigation and Water Rights." This, after careful revision, was published as Bulletin No. 1 of the office, the subject of artesian wells and underflow waters having been covered by the elaborate reports thereon for the years 1891 and 1892. An inquiry was undertaken into the practical methods and results of irrigation and its development in the arid regions of the United States, with the object of publishing the information so obtained in a bulletin from this office.

The object of such publication is to furnish reliable information representing the results of the actual experience of those who, by their genius and labors, have been successful in creating farms by the application of irrigation methods of their own invention. This bulletin will contain also results of irrigation in Europe, where it can be said that all the attendant questions, engineering and physical, have been well settled by long and careful practice. The proposed bulletin is intended to be an answer to the many and continual calls upon this office for information as to how the waters of irrigation are applied to the various soils of the arid regions of this country for the purpose of raising crops. These demands come not only from all parts of the United States but from many places in Europe, and answering these inquiries takes up a large part of the time and attention of this office. To gather in a systematic form the information needed for the production of the proposed bulletin, there have been printed and sent out several thousand copies of a circular letter containing questions to be answered by the correspondents addressed. While this is a slow method, it is believed that it will prove a success.

There is much need of an enlargement of the operations of the Weather Bureau so as to include a careful and systematic measurement of the water contained in the snowfall and of the rains upon the summits of the various mountain ranges within the arid regions.

It is from this source that the great bulk of water comes which is used in irrigation in the regions under consideration. At present we know little or nothing upon this important physical question within the arid regions, for the reason that about all the observing stations of the weather service are located in the vallies or else low down on the mountain sides much below the snow fields of their summits.

There should be undertaken at once an accurate gauging of the velocity and flow of all the streams of the arid regions, which operations will require the establishment of permanent scales for the purpose. The observation of snow and rainfall upon the mountains and the measurement of the streams of the arid regions might, no doubt, be intrusted to voluntary weather observers of the several States and Territories where the work is to be done, there being an organization, it is believed, in all of them. The measurement of the snow and rainfall and the gauging of the streams of the arid regions, as above pointed out, are vital to the interests of those who farm lands by the use of irrigation waters, for until it is done it can not be known how many acres can be put under cultivation by use of the water thus naturally stored by the mountains and delivered by the streams leading from them to the tillable lands adjacent thereto.

It is for want of this knowledge that in many localities there has been more land put under cultivation than there is water to irrigate with, and to this cause is attributable by far the largest part of the litigation of water rights in the arid regions of this country.

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